THE 1974 PREOPERATIONAL ZOOPLANKTON INVESTIGATIONS RELATIVE TO THE DONALD C. COOK NUCLEAR PLANT

By

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ABSTRACT

This report presents the results of investigations conducted in 1974 as part of the zooplankton preoperational study relative to the Donald C. Cook Nuclear Plant. Temperature and Secchi disc data collected during seven monthly surveys (April to October) are described. Zooplankton data collected during each survey cruise are presented in addition to data collected from the intake waters of the power plant in November 1974 and January 1975. These data are used in conjunction with physical data to provide a description of fluctuations in zooplankton standing stock and species composition during the four seasons of the year.

Spatial heterogeneities in zooplankton distributions over the survey area in spring (April), summer (July), and autumn (October) were analyzed by using principal component analyses. Zooplankton were least abundant close to shore (within the 5-10 meter depth contour) and most abundant offshore (beyond the 15-20 meter but within the 40-meter depth contour). Selective fish predation by planktivorous fish such as the alewife, smelt, spottail shiner, trout perch, and yellow perch appeared to be of great importance in contributing to differences in abundance and species composition of zooplankton between zones. The direction of water flow was of secondary importance, while phytoplankton abundance and species composition appeared to exert a minor influence, if any.

Further studies were conducted in 1974 to refine the sampling techniques currently being used as part of the 1975 postoperational condenser-passage study. One study investigated whether or not zooplankton were heterogeneously distributed in the forebay at any one sampling time. While zooplankton did vary in abundance at the various locations within the intake forebay, a statistically representative sampling location was determined.

A new sampling apparatus was designed to collect zooplankton for the mortality studies; the earlier apparatus was extremely damaging to the zooplankton during the collection process. Further studies were continued in the use of vital dyes as an aid in distinguishing between living and dead zooplankton. Erythrosin B was promising but proved unreliable, and the 1975 postoperational studies continue to use visual methods to separate living and dead zooplankton.

Core samples were collected at the 6-meter and 9-meter depth contours as part of a joint benthos-zooplankton study of the macro- and micro-invertebrates which live in the vicinity of the intake and discharge structures of the power plant. Epibenthic zooplankton were very abundant and consisted both of epibenthic forms and forms commonly associated with the plankton. Some of the epibenthic zooplankton enter the water column at night and may become subject to condenser passage.

ACKNOWLEDGMENTS

The contributions of John Stewart, Sally Kleinschmidt, Mohammed Omair, Bethany Hawkins, Thomas Wurster, and Gary Gaul in processing the zooplankton samples, performing calculations, and preparing initial graphs and tables are gratefully acknowledged. Gary Gaul and Daniel Sell prepared the final graphs which appear in this report.

Edward Johnston provided advice on the statistical analyses of the zooplankton data. Thomas Wurster assisted in the principal component analyses of the data collected during several survey cruises. Jeanne Harris and Ann Amundsen have written computer programs and designed a data base management system for the preoperational data. Dorothy Mohler provided excellent keypunching services.

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John Dorr and Gregg Gitschlag collected the core samples under the direction of Samuel Mozley. They and other members of the fish crew assisted on other occasions in the collection of living material. Sam Mozley provided us with the opportunity to examine the core samples, and was helpful in several other aspects of the sampling program.

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John Ayers, Erwin Seibel, Edward Johnston, Samuel Mozley, and David Dow reviewed the first manuscript and made several valuable criticisms. Liz Ayers typed the main body of the report and Janine Graham typed the tables which appear in the Appendix.

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INTRODUCTION

The Donald C. Cook Nuclear Plant is located on the southeastern shore of Lake Michigan. Construction of the power plant began in 1969. As of February 1975, Unit 1 of the plant was operational while construction of Unit 2 had yet to be completed.

Cooling water is drawn from Lake Michigan through three intake pipes located 686 m offshore in 7.3 m of water (Fig. 1). At full operating capacity, approximately 1,646,000 gal/min (7,483 m^3/min) are drawn from the lake. Ten minutes later the water is returned to Lake Michigan through two discharge pipes located 366 m offshore in 5.5 m of water (United States Atomic Energy Commission 1973).

When the power plant became operational it may have begun to adversely affect various regions of the lake or areas along the shoreline. Limnological and terrestrial studies of the flora and fauna in the vicinity of the power plant were started a number of years ago. These studies provide a data base from which descriptions of preoperational conditions can be made. The studies also may allow predictions and/or estimates to be made of the environmental impact which results from the operation of the power plant. This report deals with the 1974 preoperational zooplankton investigations.

The zooplankton investigations will be focused primarily on their role in the normal functioning of the lake ecosystem. Zooplankton as consumers of phytoplankton do in some ways affect the species composition of the phytoplankton (Porter 1972), although it is more generally believed that the size distribution of the phytoplankton determines the species composition of the zooplankton (Gliwicz 1969). As producers of fecal pellets and carcasses, zooplankton may affect the quality of the lake water and the abundance and species composition of the benthos (Lellak 1966). As many species of fish are size-selective in their feeding (Brooks and Dodson 1959; Hrbacek and Novatna-Dvorakova 1965; Wells 1970), the species composition and abundance of zooplankton in an area may affect and be affected by the distribution of fish.

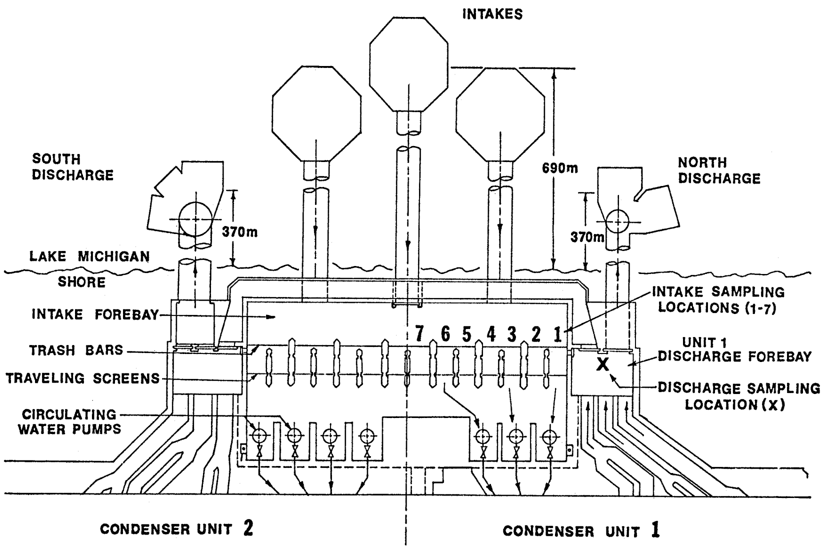


FIG. 1. A schematic view of the condenser cooling-water system of the Cook Nuclear Plant.

The zooplankton investigations began in 1970 when a large survey grid was designed and a number of stations selected (Ayers et al. 1969). The number of stations which have been examined has varied over the years; currently 30 are studied during the three major cruises (Fig. 2) and 14 stations during the four or five short cruises of each year. The station grid has a 253 square km area and extends 11 km offshore and 11 km north and south of the plant site.

Although the plume is expected to be thermally detectable only within 1.5 km of the plant site, the survey grid extends well beyond this area. In the zooplankton studies, this allows stations located far from the plant site to serve as controls when the stations close to the plant site are examined for the possible impacts that the operation of the plant may have on the zooplankton. As the plume may flow in a number of directions, including offshore, it was necessary to have the survey grid extend some distance along the shore and out into the lake.

The zooplankton program has three goals. First, it has attempted to determine which zooplankton species were present within the survey area during the preoperational period and how their abundances varied from month to month. These surveys have been limited to the period April through October for most years, although November cruises were completed in 1971 and 1972. The results of these cruises have been reported for 1970 (Ayers et al. 1971, 1973a); 1971 (Ayers et al. 1974); 1972 (Roth 1973); and 1973 (Stewart 1974). The 1974 field survey data appear in this report.

The second objective is to investigate the spatial variations in zooplankton abundances over the survey area in the preoperational years. This is an important study as the plume is expected to flow over different areas of the survey grid at different times of the year and may affect different populations of zooplankton. By investigating the factors which contribute to spatial heterogeneities in zooplankton distributions, it may become easier to understand the functioning of the aquatic ecosystem and thus predict how the plume may affect different components of that system. The results of investigations of the spatial heterogeniety in zooplankton distributions in April (spring), July (summer)

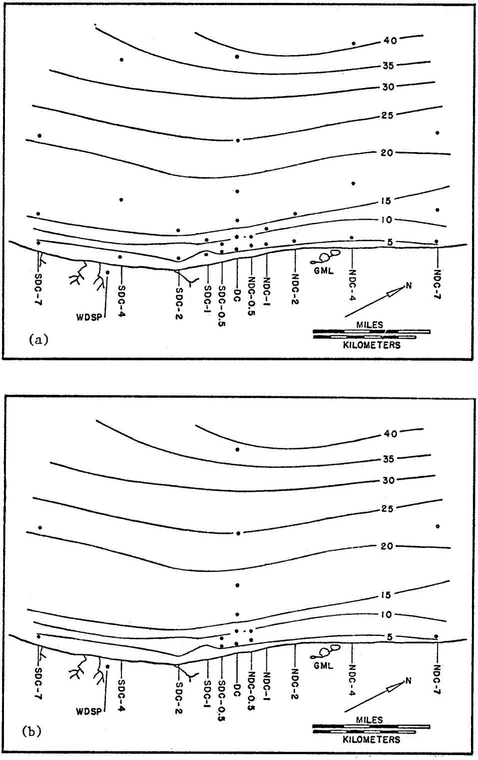


FIG. 2. Survey grids and station locations for (a) major surveys and (b) short surveys.

and October 1974 (autumn) are discussed in this report.

The third objective of the zooplankton study is to determine the degree to which zooplankton abundances and species compositions vary from one year to the next. This has not yet been done in detail, and the results of this study will appear in a later report. Initial analysis indicates that in the spring the temperature of the water is an important factor in controlling the abundances and species composition of the zooplankton. The first section of this report presents the water temperature and Secchi disc data which were collected in 1974.

In 1975, when the power plant became operational, the zooplankton investigations were expanded. Zooplankton collections were made in the intake water (in the forebay) and in the discharge water (in the discharge bay), and the numbers and species compositions of these organisms were determined. The percentage mortality of the zooplankton in these two areas was determined. Part of 1974 was spent in attempting to select a statistically representative sampling location in the forebay and in improving collecting and handling techniques for the zooplankton live-dead determinations. The results of these investigations are presented in Sections 4 and 5 of this report.

A study was made in July 1974 of the epibenthic zooplankton in the vicinity of the intake and discharge structures. These zooplankton are not sampled as a regular feature of the zooplankton investigations, but it was thought that a series of samples would be of use because: 1) the epibenthic zooplankton may be subject to condenser passage and/or entrainment; 2) the epibenthic zooplankton may be a significant food source for the various planktivorous fish and benthos which occur in the nearshore area; 3) as carnivores and detritus feeders, the epibenthic zooplankton may consume zooplankton which are damaged or killed during condenser passage and then settle out of the water column near the power plant. Epibenthic zooplankton may therefore be indirectly affected by the plume location. The results of this study are presented in Section 6 of this report.

The results of the 1974 preoperational zooplankton investigations are presented in six sections, each with its own discussion. A complete bibliography appears at the end of the report.

SECTION 1

THE TEMPERATURE AND SECCHI DISC DATA COLLECTED DURING THE 1974 SURVEY CRUISES

INTRODUCTION

Temperature is probably the most frequently measured variable in limnology and oceanography. Physicists, chemists and geologists determine temperature in order to estimate the rate of various processes. Biologists measure temperature in order to describe the thermal characteristics of the water in which organisms live and in the water from which they are excluded. For those organisms whose physiology is well understood, a description of the water temperature gives an indication of the rate of various metabolic processes.

The density of fresh water is almost entirely dependent upon its temperature. As water flows along planes of equal density, the measurement of the temperatures of a water body may give an indication of its direction of flow. The direction of surface water flow is strongly influenced by wind direction.

The temperature of surface water is dependent largely upon meteorological conditions. Water temperature fluctuates annually with the changing seasons and the varying amounts of solar radiation. Lake temperatures may also vary quite markedly from year to year as meteorological conditions change. Measurements of surface-water temperatures can give an indication of earlier meteorological events.

Secchi disc readings are commonly made by biologists; these readings give an indication of the transparency of the water. Suspended solids of many types affect the transparency of waters; however, in the oceans and the open waters of lakes where the input of colloids and solids from terrestrial sources is small, phytoplankton cells are probably the most important reducers of light penetration. Secchi disc readings have frequently been used to give a rough indication of the standing stock of phytoplankton where Secchi disc readings are inversely related to standing stocks of phytoplankton (Ladewski and Stoermer 1973).

Secchi disc readings and surface-temperature measurements have been determined during all the survey cruises since 1971. Beginning in 1974, temperature profiles were determined at all stations during each cruise.

The current pattern in Lake Michigan has been described by Ayers et al. (1958), and for the inner mile of the survey grid by Ayers and Huang (1967) and Ayers et al. (1967). Generally, the inshore waters (1.5 km from shore) flow parallel to the shore with the current direction and speed varying with the velocity of the wind. In the summer, the flow is most frequently to the north while in the winter it is frequently to the south. In the summer, the Michigan City-Benton Harbor eddy forms in the offshore region where it rotates in a counterclockwise direction.

Upwellings are common during the summer and autumn (Seibel and Ayers 1974) and occur when subsurface offshore water is transported inshore during certain meteorological and limnological conditions. Limnological conditions in the inshore region may be drastically altered during an upwelling. The inshore region may be enriched with nutrients, and the standing stock of phytoplankton may increase. Upwelled water may bring in deep-water forms of zooplankton which are not normally found in the inshore area during the summer. Inshore fish may avoid the relatively cold upwelled waters and may concentrate in areas away from the upwelling.

METHODS

Surface temperatures were measured either by collecting a bucket of water and measuring the temperature with a thermometer or by lowering a thermistor into the water and reading the temperature on a YS-1 recorder. Beginning in 1974, temperature profiles were measured regularly at all stations by using an electronic bathythermograph and a chart recorder. With the settings used, temperature could be read to an accuracy of ± 0.5°C and depth with an accuracy of ± 0.25 m. At each station, both descending and ascending traces were recorded from the surface of the water to the bottom of the water column and from the bottom to the surface of the water column.

Secchi disc readings were measured by using an 8-inch diameter Secchi disc. Measurements could not be made at all stations as some stations were occupied after sunset.

RESULTS

20 April 1974

April is usually a period of warming of the lake water. Surface temperatures (Fig. 3a) were highest inshore, reaching a maximum of over 8°C and decreasing offshore to less than 4°C. The thermal bar was approximately 11 km offshore.

The isotherms ran parallel to the shoreline. The water flowed parallel to the shore with some of the warmer inshore waters mixing out into the colder offshore waters. The water column was isothermal (Fig. 4) at all stations. The water was easily mixed so that heating which occurred at the surface was rapidly transferred throughout the water column.

The lowest Secchi disc readings (Fig. 3b) occurred inshore and were less than 1.5 m; these low values may be indicative of a high standing stock of phytoplankton. The inshore area was probably favorable to phytoplankton production at this time of the year because of high dissolved nutrients, relatively high temperatures, and the shallowness of the water column which prevented phytoplankton from being mixed below the compensation depth. Conversely, conditions were less favorable offshore primarily because of the low temperature of the water and because the depth to which phytoplankton were mixed was probably greater than the compensation depth. Secchi disc readings offshore were over 4 m.

15 May 1974

Surface-water temperatures were approximately 3°C higher in May (Fig. 5) than in April. At the stations closest to shore, temperatures were 10° to 11°C while 11 km offshore they were 7°C. The isotherm and probably the water flow were parallel to the shore.

The water was isothermal at most stations (Fig. 6). There was, however, a small amount of stratification in the water column 11 km offshore.

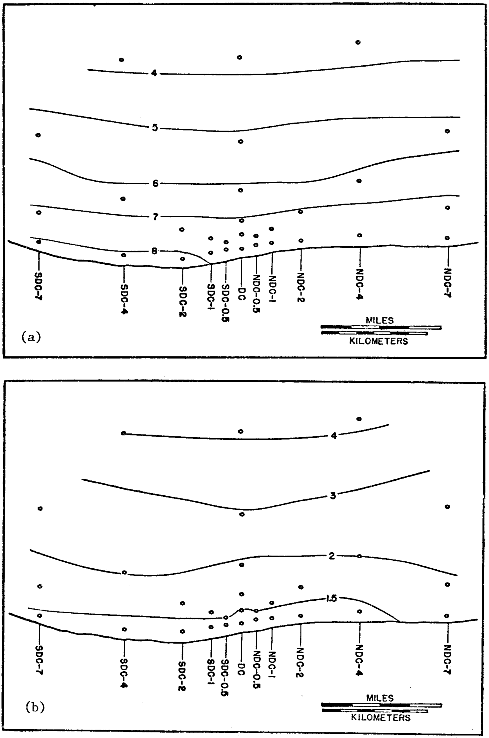


FIG. 3. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 20 April 1974.

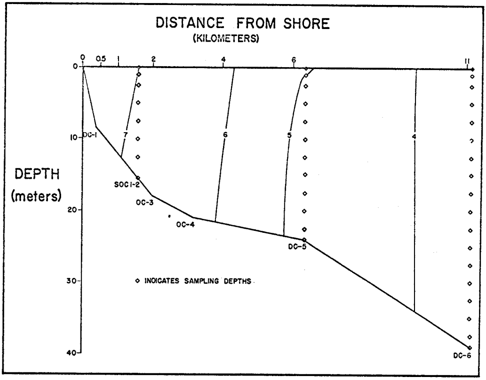


FIG. 4. Temperature profiles with depth along the DC-transect on 20 April 1974.

Within 1.5 km of shore, Secchi disc readings were less than 2 m (Fig. 5a,b). Further offshore, readings were 2-3.5 m. Readings were higher in May than in April with the exception of stations located 11 km miles offshore. These data suggest that while the phytoplankton standing stock was high in May, it was slightly less than that in April with the exception of the area furthest offshore.

13 June 1974

Surface temperatures in June (Fig. 7a) were 5-6°C higher than in May. Inshore temperatures were 15-17°C while offshore temperatures were 12°C.

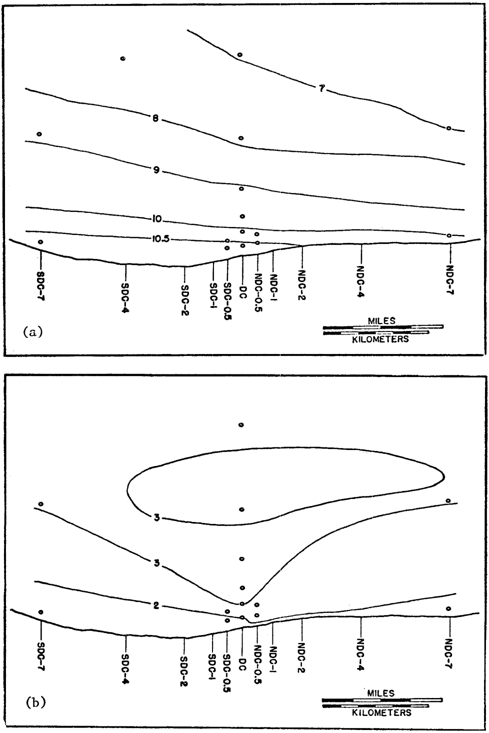


FIG. 5. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 15 May 1974.

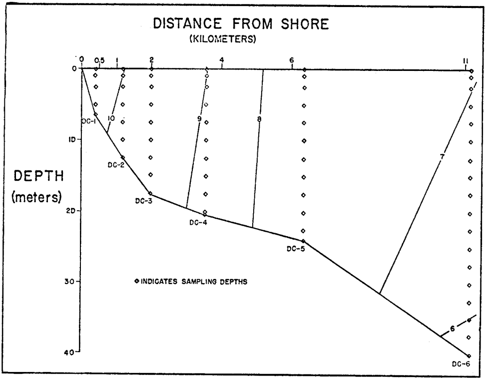


FIG. 6. Water temperatures with depth along the DC-transect on 15 May 1974.

The water column (Fig. 8) was stratified. The greatest thermal stratification was exhibited at the stations furthest from shore; stations within 1.5 km of shore had only a small amount of thermal stratification. This stratification divided the water column into a warm epilimnion and a colder hypolimnion, tending to prevent nutrients which were regenerated in the deep water from being mixed back up into the surface waters. Secchi disc readings (Fig. 7b) were less than 3 m close to shore, and at 11 km offshore increased to over 5 m. These values were higher than in May and suggest that there had been a reduction in the standing stock of phytoplankton.

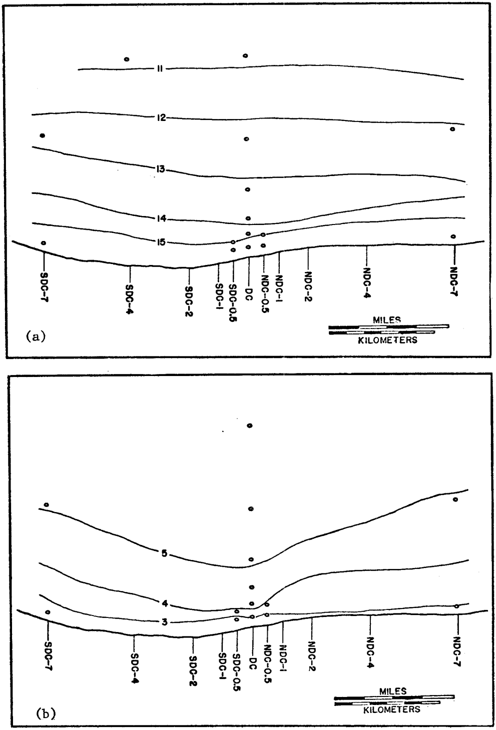


FIG. 7. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 13 June 1974.

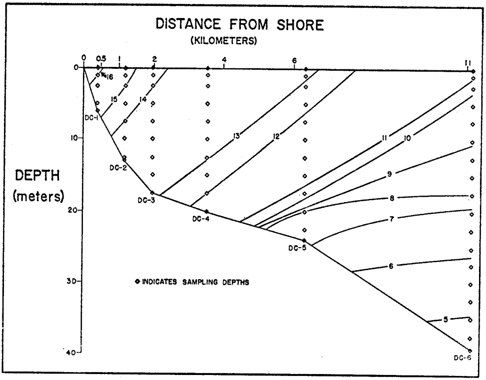


FIG. 8. Water temperatures with depth along the DC-transect on 13 June 1974.

11 July 1974

The July cruise (Fig. 9a) was during an upwelling. Inshore temperatures were less than 13°C in the center of the upwelling and increased to 17°C north and south of the upwelling. Eleven kilometers offshore, temperatures reached a maximum of 21°C.

The upwelling is well illustrated in Figure 10 which shows the temperature-depth profile along the DC-transect. The isotherms slope upwards toward the shore. At stations which were within 6-8 km of shore, the deep water was colder in July than in June. July was a period of strong thermal stratification of the water column.

There was a rough correlation between Secchi disc readings (Fig. 9b)

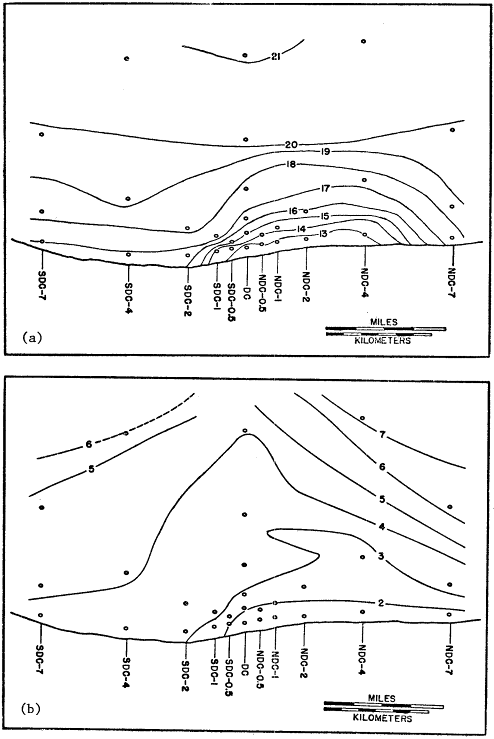


FIG. 9. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 11 July 1974.

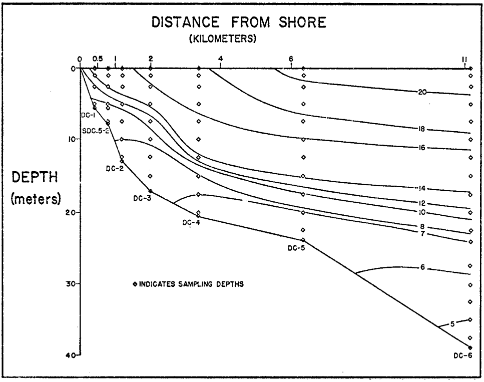


FIG. 10. Water temperatures with depth along the DC-transect on 11 July 1974.

and the center of the upwelling. Values were less than 2 m close to shore and in the center of the upwelling, and were over 3 m south of the upwelling. Values increased to 3-5 m over most of the offshore area with high values of 6-7 m occurring at the extreme offshore corners of the survey grid.

22 August 1974

Surface temperatures (Fig. 11a) were higher in August than in July. Inshore temperatures were less than 22.5°C north of the plant and were greater than 23°C south of the plant. Temperatures increased offshore to nearly 24°C. As the cooler water was found close to shore, the cruise

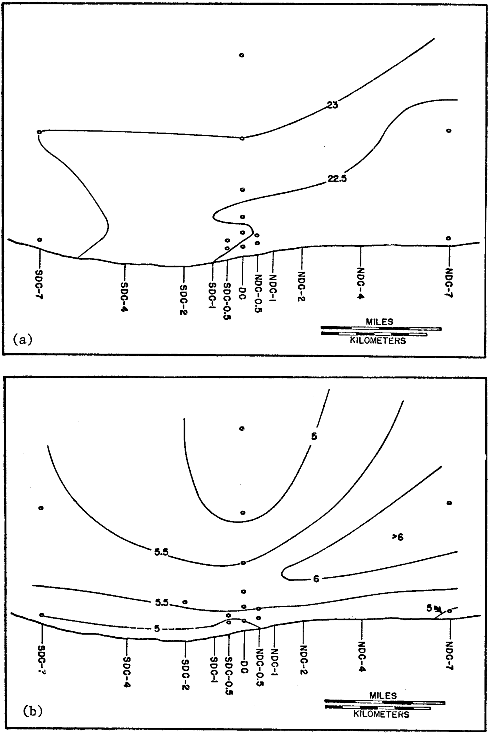


FIG. 11. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 22 August 1974.

may have been taken at the beginning of an upwelling. The water was strongly thermally stratified (Fig. 12).

Secchi disc readings (Fig. 11b) were less than 5 m close to shore and increased to 5-6 m offshore. These high readings may indicate a low standing stock of phytoplankton.

12 September 1974

The EBT data for September are incomplete. An intermittent short circuit in the electronics resulted in traces which, at certain stations, indicated surface temperatures which varied by more than 1°C from that indicated by the YS-1 thermistor. At some stations the depth trace was inaccurate.

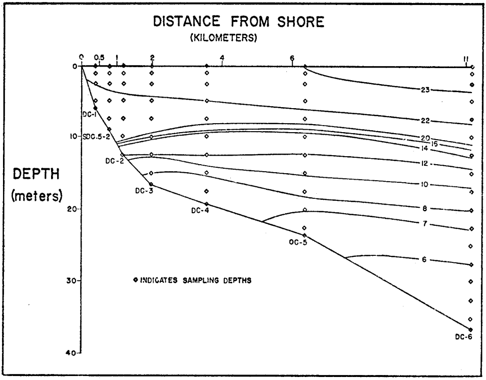


FIG. 12. Water temperatures with depth along the DC-transect on 22 August 1974.

Surface water (Fig. 13a) was generally warmest (19.5°C) close to shore and decreased to less than 18.5°C 11 km offshore. There was a tongue of cooler water (<19.5°C) centered on the DC-transect and extending approximately 1.5 km offshore. A second mass of cooler water (<19.5°C) was located 3-6 km offshore along the southern half of the survey grid.

Surface temperatures were lower than in August. The few good EBT traces (Fig. 14) which were obtained indicated that the thermocline was still well developed in the offshore region but was weak in the inshore region. Therefore this cooling of the surface water may have been associated with the autumn breakdown of the thermocline. Lower water temperatures also may have been associated with an earlier upwelling.

Secchi disc readings (Fig. 13b) were lower in September than in August. Values were 3-4 m close to shore and increased to a maximum of 4.5 m offshore. September therefore may have been a period of increased standing stock of phytoplankton.

9 October 1974

October was a period of cooling of the surface waters (Fig. 15a), and there was approximately a 5°C decrease in temperatures below September values. Temperatures were slightly lower than 14°C inshore and increased to a little over 14°C offshore. The thermocline was broken down nearshore (Fig. 16).

Secchi disc readings (Fig. 15b) were low. Values were less than 2 m in the inner 3-km from shore and increased only to 3 m 11 km offshore. October was therefore a period of cooling, of mixing of hypolimnetic and epilimnetic waters, and possibly a period of increased phytoplankton standing stock.

DISCUSSION

The temperature and Secchi disc data illustrate the well known seasonal patterns of lake temperatures and phytoplankton standing stocks. Water temperatures, which are minimal in winter, increase in the spring. Associated with this increase is a probable increase in primary production and in the standing stock of phytoplankton.

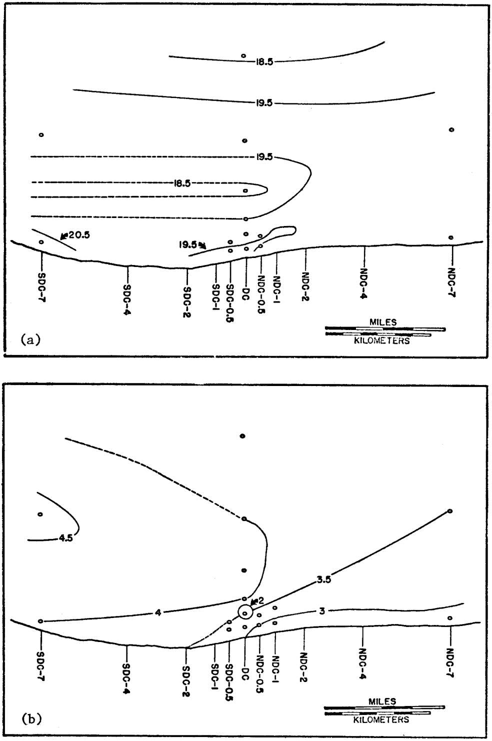


FIG. 13. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 12 September 1974.

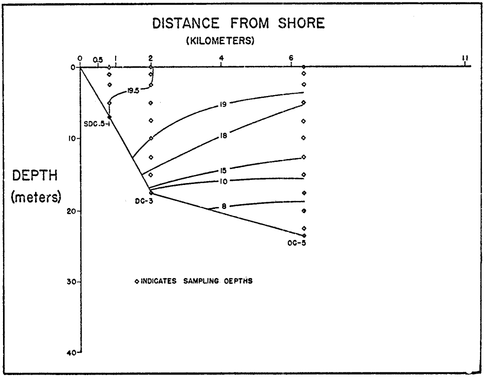


FIG. 14. Water temperatures with depth along the DC-transect on 12 September 1974.

With continued warming at the surface, thermal stratification develops in the water column during June and becomes more intense throughout the summer. This stratification presents a barrier to the movement of nutrient-rich hypolimnetic water into the epilimnion, probably resulting in a decrease in primary production and in the standing stock of phytoplankton in the epilimnion. Upwellings occur throughout the summer and are a mechanism by which nutrients are transferred back into the surface waters.

Cooling of the water column begins in the autumn, and the thermal stratification of the water is reduced and lost. As the water becomes isothermal it is more readily mixed and there is an exchange between epilimnetic and hypolimnetic waters, resulting in an increase in the

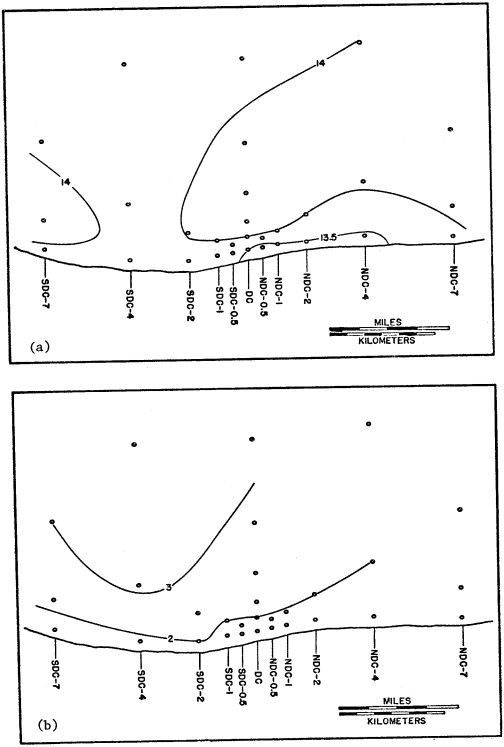


FIG. 15. (a) Surface-water temperatures, °C, and (b) Secchi disc depths, m, on 9 October 1974.

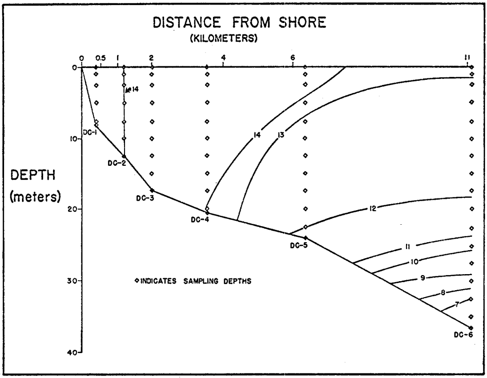


FIG. 16. Water temperatures with depth along the DC-transect on 9 October 1974.

amounts of dissolved nutrients in the surface waters and possibly a second period of increased primary production and standing stock of phytoplankton.

This pattern, while basic to the lake, is subject to considerable variation from one year to the next. Initial analyses of the preoperational temperature data suggest that spring of 1972 was considerably colder than in 1971, 1973, or 1974. Conversely, 1973 was generally a year of relatively warm lake temperatures.

The temperature of the thermal plume may vary quite markedly during the summer depending upon whether or not there is an upwelling. During most of the summer, the intake cribs will draw in epilimnetic water (and associated epilimnetic zooplankton) with temperatures as high as 22°C.

Assuming that the water is heated 11°C during condenser passage, the discharged cooling water may approach temperatures as high as 33°C. This temperature approaches the lethal limits for epilimnetic zooplankton. Conversely, during an upwelling, hypolimnetic water with temperatures of 8°C or less will pass through the condensers and the resulting discharged water will have maximum temperatures of 19°C. During an upwelling, hypolimnetic zooplankton with their probable narrow range of thermal tolerances may pass through the power plant and then eventually appear in the surface waters of the thermal plume.

Meteorological conditions which cause upwellings may also alter the direction of flow of the thermal plume. During an upwelling the surface waters move offshore and the thermal plume may also move offshore rather than hug the coast.

A thermal plume which contains condenser-passed water from the hypolimnion would have slightly higher concentrations of dissolved nutrients than the surrounding eplimnetic waters. This may result in an increase in primary production (and possibly standing stock of the phytoplankton) in the immediate area of the plume. However, because of the tremendous dilution of condenser water by lake water, this may not be a significant increase.

SECTION 2

THE SEASONAL AND SPATIAL DISTRIBUTIONS OF ZOOPLANKTON IN THE SURVEY AREA DURING 1974 AND EARLY 1975

INTRODUCTION

Field surveys in 1974 were conducted in much the same manner as in 1972 and 1973. Data from the 1974 cruises provide additional information on the spatial and seasonal variability in the distribution and composition of the zooplankton. The same format is used as Stewart (1974) used for the 1973 data.

The 1974 field data provide further information on the year-to-year variations in zooplankton abundances. These variations have not yet been subjected to rigorous analyses and so are not included in this report. However, the analyses are being made and the results will appear in a later report.

METHODS

Methods used in the 1974 field season were the same as in 1973. Zooplankton were collected over the major survey grid (Fig. 2 a) in April, July, and October, and over the short survey grid (Fig. 2 b) in May, June, August, and September. Poor weather and rough lake conditions prevented taking the November cruise.

Plankton were collected at each station with a 50-cm diameter plankton net (mesh size, 156 μ). A calibrated flowmeter mounted in the mouth of the net allowed estimates to be made of the amount of water filtered during each vertical haul. Each vertical haul was made from as close to the bottom as possible to the surface; three hauls were made at each station. The flowmeter was read, the net washed down with water from a hose, the contents of the cod-end transferred to a labelled jar, and the sample preserved with Koechie's fluid (a sugar-formalin solution).

In the laboratory, zooplankton in the first two replicate samples were counted; the third sample was occasionally examined when there was poor agreement between the counts in the first two replicates. Each

sample was subdivided in a Folsom plankton splitter as many times as necessary to give two subsamples of 350-500 zooplankters each. These subsamples were counted to the genus or species level, depending on the station and the cruise. A third subsample of 700-1,000 zooplankton was examined for the rare zooplankton (less than 40 animals and 10% of the subsample). Zooplankton were enumerated in a circular counting dish; a stereozoom microscope was used.

Zooplankton dry weights were determined on samples containing relatively small amounts of phytoplankton and detritus. Each subsample was visually examined and a subjective judgment made as to whether the zooplankton contributed to the major fraction of the biomass of that sample. Biomass determinations were made on less than half the stations. Inshore stations during all months generally had large amounts of phytoplankton and detritus, as did many of the midshore and offshore stations during the spring and summer.

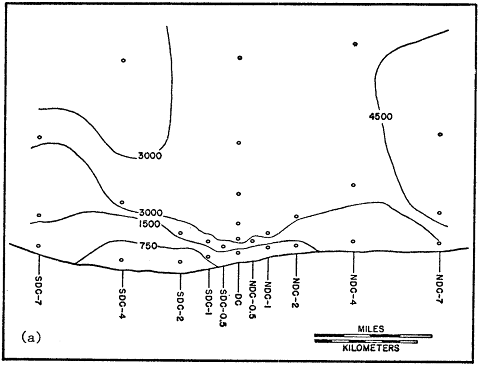
After the plankton subsamples had been examined and the numbers and species compositions of the zooplankton determined, the subsample was vacuum-filtered on a preweighed Whatman filter, oven dried at 100°C for 4 hr, and then weighed 1 min after removal from the drying oven. Calculations were made of the mean dry weight of zooplankton per cubic meter of water at each station and of the mean dry weight per individual zooplankter.

RESULTS

The results are presented for each survey cruise, including descriptions and graphs of the distributions and abundances of the major taxa of zooplankton. The data for each station also appear in the Appendix.

Major Survey, 20 April 1974

The abundance of total zooplankton (Fig. 17a) varied from less than $1,000/m^3$ within 1 km of shore to over $5,000/m^3$ offshore. The zooplankton were numerically dominated by the copepods, which were reproducing at this time. Nauplii and adults were the most abundant forms.



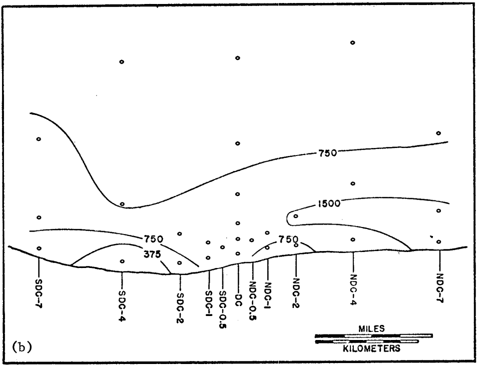
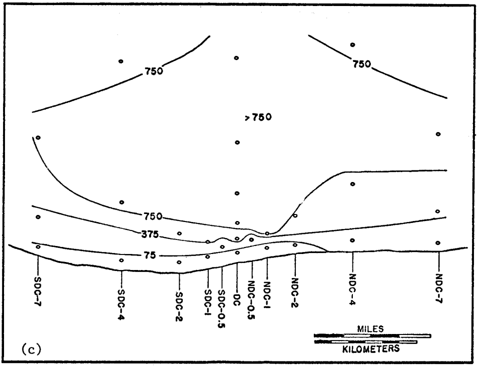


FIG. 17. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected on 20 April 1974. (a) Total zooplankton; (b) nauplii.



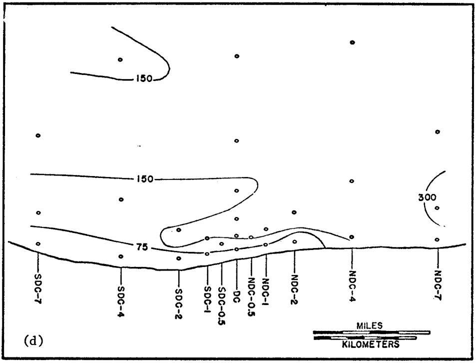


FIG. 17 continued. (c) Adult and (d) immature *Diaptomus* spp. copepodites.

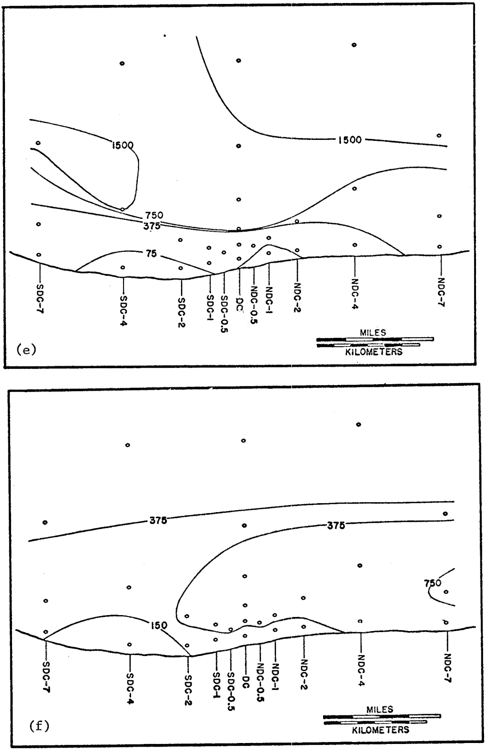


FIG. 17 continued. (e) Adult and (f) immature *Cyclops* spp. copepodites.

Nauplii (Fig. 17b) occurred in concentrations of 400-3,000/m^3 with maximum densities occurring offshore. Adult *Diaptomus* spp. (Fig. 17c) were least abundant within 1 km of shore (20-250/m^3) and increased rapidly with distance offshore to a maximum of 1,300/m^3. The inshore *Diaptomus* were dominated by *D. ashlandi* although *D. minutus* and *D. oregonensis* also occurred; *D. ashlandi* was also the dominant species offshore. Apparently *D. sicilis* occurred only in the colder, deeper offshore waters. Immature *Diaptomus* spp. copepodites (Fig. 17d) were less abundant than adults. There were less than 100/m^3 within 1 km of shore and south of NDC 4-4; maximum offshore concentrations were 150-300/m^3.

Cyclops adults (Fig. 17e) were slightly more abundant than *Diaptomus* spp.; *Cyclops bicuspidatus* adults were the only species observed. Zooplankton densities were less than 100/m^3 within 1 km of shore and south of NDC 4-4 and increased to over 1,500/m^3 offshore. There were 75-500/m^3 immature copepodites within 1 km of shore; offshore the abundance (Fig. 18f) increased to over 800/m^3.

Other species of copepods occurred only sparsely. *Limnocalanus macrurus* was found offshore in maximum densities of over 80/m^3; this species was reproducing and immatures were the dominant form. *Tropocyclops prasinus mexicanus* adults were most abundant offshore and reached maximum densities of over 60/m^3 11 km offshore. Immatures were not observed.

Cladocerans formed only a small component of the total zooplankton. *Bosmina longirostris* and *Daphnia* spp. were the dominant forms; *B. longirostris* occurred in maximum densities of 40/m^3 at 1-6 km from shore while *Daphnia* spp. were most abundant (less than 25/m^3) at 1-3 km from shore. *Daphnia geleata mendotae, D. retrocurva,* and *D. longiremis* were all present. *Chydorus sphaericus* and *Eubosmina coregoni* occurred in low densities within 3 km of shore. Sporadic distributions of *Holopedium gibberum* and the rotifer *Asplanchna* spp. were also found within 3 km of shore.

Short Survey, 15 May 1974

The May zooplankton were again dominated by the copepods. However,

the dominant forms were immature copepodites rather than nauplii and adults as was observed in April. Total zooplankton abundances (Fig. 18a) were 5-8 times greater than in April. The lowest zooplankton densities of less than $6{,}500/m^3$ occurred within 1 km of shore; they were most abundant (over $16{,}000/m^3$) 5-8 km offshore.

Nauplii (Fig. 18b) were more abundant than in April although they accounted for a smaller fraction of the total zooplankton. Concentrations were less than $800/m^3$ within 1 km of shore and increased to over $4{,}000/m^3$ 6 km offshore.

Diaptomus spp. adults (Fig. 18c) were less abundant than in April. As in April, adults were least abundant inshore (less than $80/m^3$) and increased with distance offshore to a maximum of over $300/m^3$. The most common species was *D. ashlandi*, followed by *D. minutus* and *D. oregonensis; D. sicilis* was the least abundant species and was found only offshore. Immature *Diaptomus* spp. copepodites (Fig. 18d) were more abundant than in April and occurred in maximum concentrations of $4{,}000/m^3$ 3-5 km from shore; they were least abundant (less than $600/m^3$) within 1 km of shore.

Cyclops spp. adults (Fig. 18e) were less abundant than in April. Low concentration ($5/m^3$) of adult *C. vernalis* was observed at DC-2; the dominant species at DC-2, DC-5 and DC-6 was *C. bicuspidatus*. Adults increased in abundance with distance offshore from less than $150/m^3$ within 1 km of shore to a maximum of over $550/m^3$ offshore. Immature copepodites (Fig. 18f) were also less abundant (less than $1{,}500/m^3$) close to shore and occurred in maximum concentrations of over $8{,}000/m^3$ 1-10 km offshore. As in April, *C. bicuspidatus* was more abundant than *Diaptomus* spp.

Other species of copepods were present and reproducing but they accounted for only a small percentage of the total zooplankton. *Epischura lacustris* occurred mainly as immature copepodites, most abundant (over $300/m^3$) 1.6 km offshore and generally absent more than 3 km from shore. Immature *Eurytemore affinis* copepodites were also most abundant (less than $50/m^3$) within 3 km of shore. Conversely, *Limnocalanus macrurus* was absent within 3 km of shore; the copepod occurred in maximum concentrations of over $80/m^3$ 3 km offshore and decreased with further distance

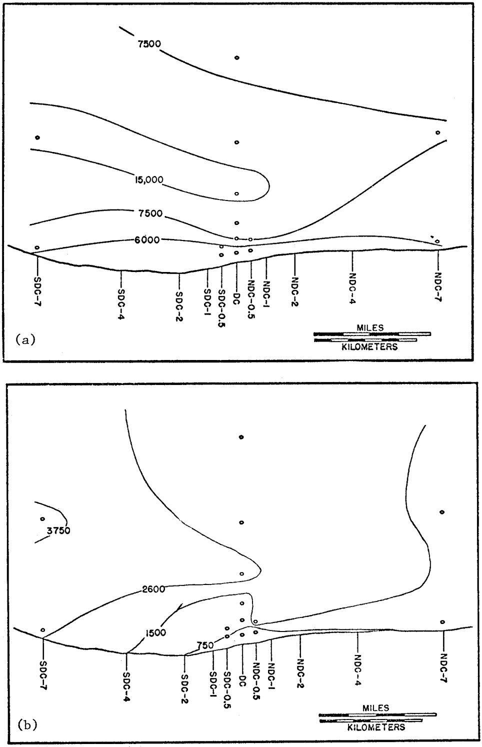


FIG. 18. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected on 15 May 1974. (a) Total zooplankton; (b) nauplii.

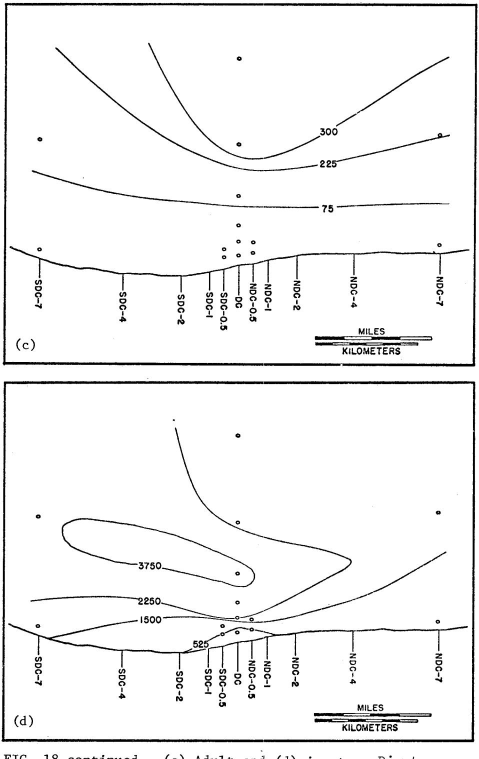
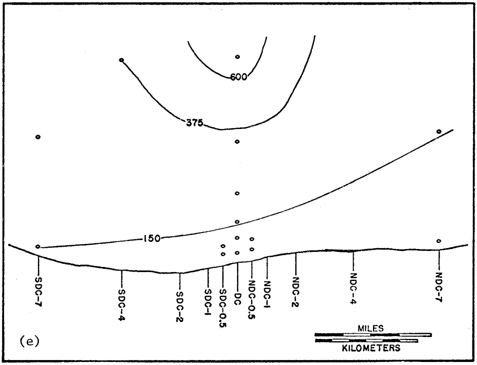


FIG. 18 continued. (c) Adult and (d) immature *Diaptomus* spp. copepodites.



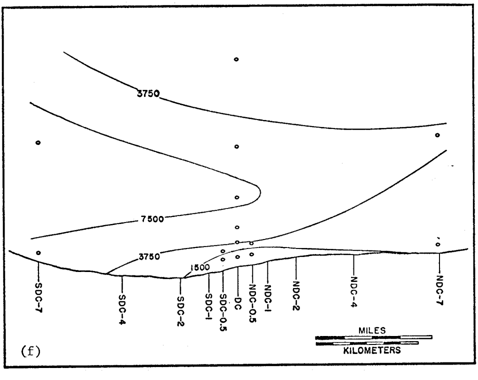


FIG. 18 continued. (e) Adult and (f) immature *Cyclops* spp. copepodites.

offshore. *Tropocyclops prasinus mexicanus* was not reproducing. Adults were most abundant (10-50/m^3) within 3 km of shore but inshore-offshore differences were not large.

Cladocerans were more numerous and accounted for a larger fraction of the total zooplankton than in April. *Bosmina longirostris* was most abundant (200-500/m^3) within 1 km of shore and became progressively rarer with distance offshore. Similarly, *Chydorus sphaericus* was most abundant (13-120/m^3) within 1 km of shore and rapidly decreased with distance offshore. *Daphnia* spp. (15-50/m^3) and *Holopedium gibberum* (7-14/m^3) were most abundant 3-6 km offshore.

Asplanchna spp. were most abundant (over 30/m^3) within 1 km of shore and decreased with distance offshore; they were more abundant than in April.

Short Survey, 13 June 1974

June was a period of increased standing stock of zooplankton, particularly in the offshore region where there was a 4-fold increase in total zooplankton abundances; in the inshore region this increase was only 25-50%. Total zooplankton abundances (Fig. 19a) were lowest (less than 8,000/m^3) within 1 km of shore and increased with distance offshore to over 30,000/m^3. The zooplankton were dominated by the copepods which were actively reproducing at this time. Cladocerans were more abundant than in May and formed a larger component of the total zooplankton.

Nauplii (Fig. 19b) increased in abundance with distance offshore from 300-800/m^3 within 1 km of shore to over 4,000/m^3 11 km offshore. *Diaptomus* spp. adults (Fig. 19c) were more numerous than in May and were probably the matured adults from the April generation of nauplii and the May generation of immature copepodites. Adult densities were less than 80/m^3 within 1 km of shore and increased to over 800/m^3 offshore. Maximum densities of over 1,600/m^3 occurred 6 km from shore and along the southern portion of the survey grid. The dominant diaptomid was *D. minutus* while *D. ashlandi* was dominant offshore; this was also observed in 1973 (Stewart 1974). Two species, *D. oregonensis* and *D. sicilis*, formed only a small fraction of the total adults; *D. sicilis*

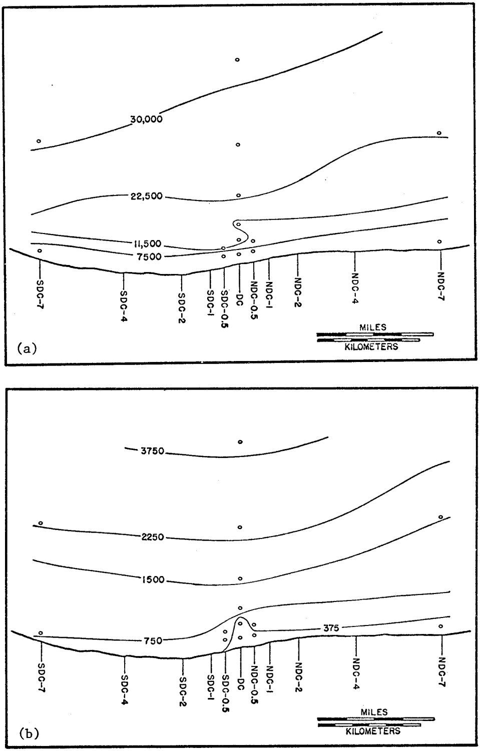
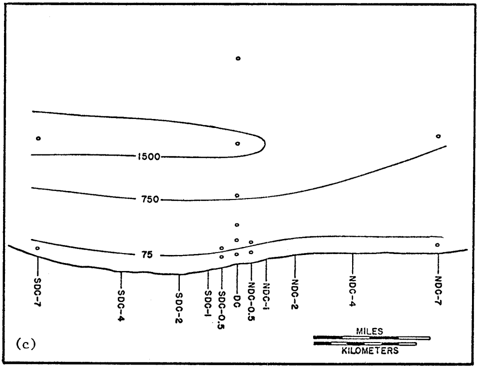


FIG. 19. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected on 13 June 1974. (a) Total zooplankton; (b) nauplii.



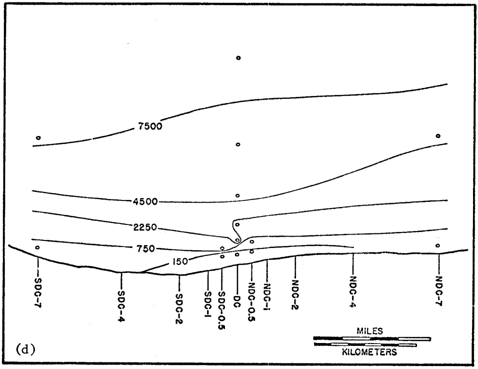
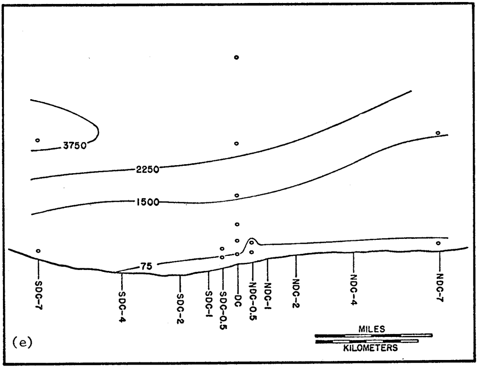


FIG. 19 continued. (c) Adult and (d) immature *Diaptomus* spp. copepodites.



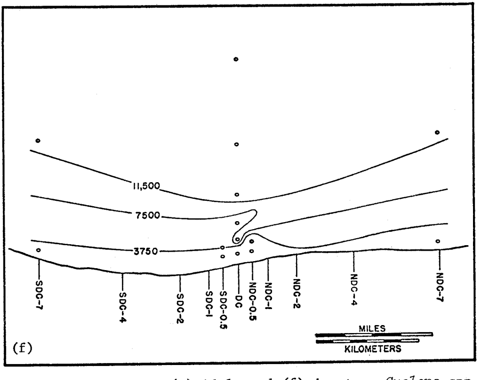


FIG. 19 continued. (e) Adult and (f) immature *Cyclops* spp. copepodites.

was found only offshore. Immature *Diaptomus* spp. copepodites (Fig. 19d) were less abundant (less than $800/m^3$) within 1 km of shore and increased with distance offshore to over $8,000/m^3$.

Cyclops spp. adults (Fig. 19e) were more numerous than in May and probably originated from the April pulse of nauplii and the May pulse of immature copepodites. Adults increased in abundance with distance offshore from less than $80/m^3$ within 1 km of shore to over $2,400/m^3$ 6 km offshore. The dominant species was *C. bicuspidatus* although low numbers of *C. vernalis* were also observed. Immature *C. bicuspidatus* copepodites (Fig. 19f) were also least abundant (less than $4,000/m^3$) inshore and increased with distance offshore to over $15,000/m^3$. As in previous months, *C. bicuspidatus* was more abundant than *Diaptomus* spp.

Other species of copepods formed only a small fraction of the total standing stock of zooplankton. *Eurytemora affinis* was reproducing and was most abundant ($40\text{-}160/m^3$) within 1 km of shore. *Epischura lacustris* was also reproducing but was found in low numbers at a few stations within 1 km of shore. *Limnocalanus macrurus* was sporadically present as adults and immatures and was not found within 3 km of shore. *Tropocyclops prasinus mexicanus* occurred only as adults. There were less than $8/m^3$ within 1 km of shore; concentrations increased to $40\text{-}125/m^3$ 1-8 km offshore.

Cladocerans were more abundant than in the preceding months. The dominant species, *Bosmina longirostris*, was most abundant ($2,700\text{-}7,600/m^3$ within 1 km of shore and decreased to less than $400/m^3$ 11 km offshore. *Daphnia galeata mendotae* and *D. retrocurva* were the most abundant *Daphnia* species; small numbers of *D. longiremis* were observed but not within 6 km of shore. *Daphnia* spp. increased in abundance with distance offshore from less than $10/m^3$ within 1 km of shore to over $250/m^3$ at DC-6. Small numbers of *Eubosmina coregoni* and *Chydorus sphaericus* were observed sporadically over the survey area and were most abundant within 1 km of shore.

Asphanchna spp. were more abundant than in May. There were more than $600/m^3$ within 1 km of shore. Minimum abundances of less than $40/m^3$ occurred 5-10 km offshore.

Major Survey, 11 July 1974

The abundance of total zooplankton was higher than in June. Zooplankton (Fig. 20a) were least abundant ($40,000/m^3$) within 1-3 km of shore with the lowest concentrations ($10,000/m^3$) occurring in the nearshore water south of the plant site. Highest zooplankton densities (over $80,000/m^3$) occurred 5-10 km offshore with a maximum concentration of $165,000/m^3$ at DC-5.

Nauplii were more abundant than in June although they accounted for less than 4% of the total zooplankton. Within 1 km of shore, nauplii occurred in concentrations of $800\text{-}3,500/m^3$ near the plant site and in lower concentrations of $70\text{-}300/m^3$ to the north and south. Nauplii decreased in abundance with distance offshore to $150\text{-}1,000/m^3$ 11 km offshore.

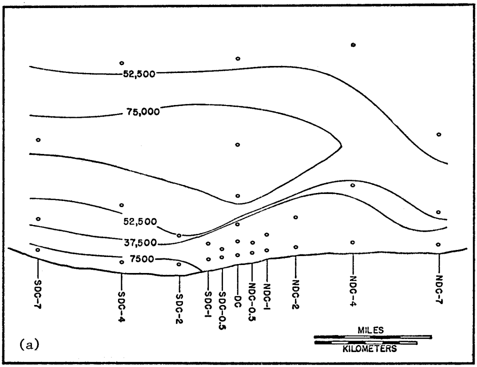
Diaptomus spp. adults were also more abundant than in June; *D. ashlandi* accounted for 60-80% and was followed in abundance by *D. minutus* and *D. oregonensis; D. sicilis* was rare and was not found within 3-5 km of shore. *Diaptomus* spp. (Fig. 20b) occurred in concentrations of $40\text{-}5,000/m^3$ within 1 km of shore and in concentrations of $1,500\text{-}8,700/m^3$ 1-6 km offshore. Further offshore, the density of adults was less than $3,000/m^3$.

Immature *Diaptomus* spp. copepodites (Fig. 20c) were slightly more abundant in the inshore area and less abundant offshore than in June. They occurred in concentrations of less than $800/m^3$ to over $4,500/m^3$ within 1 km of shore to $6,100\text{-}16,500/m^3$ 3-10 km offshore, and then decreased with further distance offshore.

Cyclops bicuspidatus adults (Fig. 20d) were more abundant in June than in July, particularly within 1-3 km of shore; their concentrations ranged from less than $800/m^3$ to over $2,400/m^3$. Abundances increased with distance offshore to over $8,000/m^3$ 3-6 km offshore and then decreased to less than $5,000/m^3$. *Cyclops vernalis* was observed in low numbers.

Immature *Cyclops bicuspidatus* copepodites (Fig. 20e) occurred in similar concentrations as in June. There were $5,800\text{-}8,000/m^3$ within 1 km of shore. Abundances were greatest (over $16,000/m^3$) 3-10 km offshore.

The other species of copepods were considerably less abundant than *Diaptomus* spp. and *Cyclops bicuspidatus*. Immature *Eurytemora affinis*



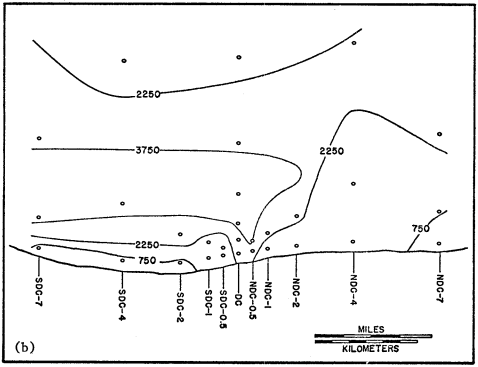
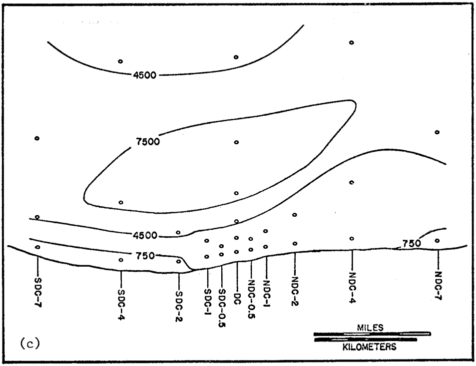


FIG. 20. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected on 11 July 1974. (a) Total zooplankton; (b) adult *Diaptomus* spp.



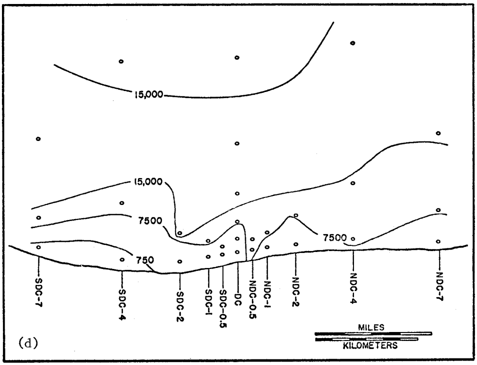
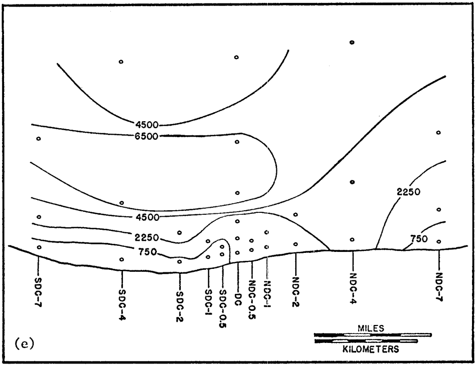


FIG. 20 continued. (c) Immature *Diaptomus* spp. copepodites; (d) adult *Cyclops bicuspidatus*.



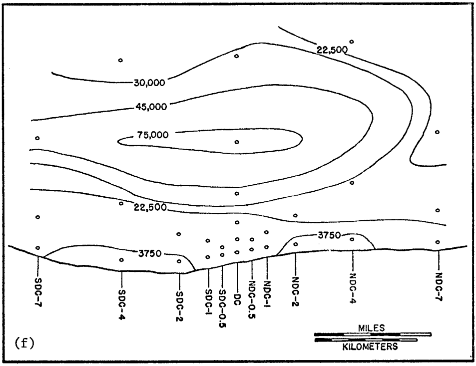


FIG. 20 continued. (e) Immature *Cyclops* spp. copepodites; (f) *Bosmina longirostris*.

occurred in maximum numbers (160-800/m^3) within 1 km of shore and decreased with distance offshore; adults were rare. Immature *Epischura lacustris* copepodites occurred sporadically and were most abundant offshore; adults were rare. *Limnocalanus macrurus* adults and juveniles were scarce and were most abundant 5-11 km offshore. Like *D. sicilis*, *L. macrurus* did not appear inshore with the upwelling. *Tropocyclops prasinus mexicanus* occurred only in the adult stage and at only a few stations.

The zooplankton were numerically dominated by the cladoceran *Bosmina longirostris* (Fig. 20f) which, over most of the survey area, accounted for more than 50% of the total zooplankton. Abundances were 10-100 times greater than in June, with the largest increases occurring offshore. Concentrations were generally less than 24,000/m^3 within 1-3 km of shore with patches of less than 4,000/m^3. With distance offshore, *B. longirostris* increased in abundance to a maximum of over 80,000/m^3 at 8 km and then decreased with further distance offshore.

Daphnia spp. were more abundant than in June. The dominant species was *D. retrocurva* accounting for 80% of the *Daphnia* spp. There were less than 80/m^3 within 1 km of shore and maximum concentrations of 250-650/m^3 5-8 km offshore.

Polyphemus pediculus, the only other abundant cladoceran, was less abundant (0-50/m^3) within 3 km of shore, increasing with distance offshore to 48-86/m^3. The cladocerans *Eubosmina coregoni*, *Holopedium gibberum*, and *Leptodora kindtii* occurred sporadically in low numbers over the survey area.

Asplanchna spp. occurred in similar concentrations as in June (0-700/m^3) although they were less abundant in the offshore regions. The maximum concentration was found north of the plant site.

Short Survey, 22 August 1974

The abundance of total zooplankton was approximately half that of July (Fig. 21a), increasing with distance offshore from less than 20,000/m^3 within 1 km of shore to over 40,000/m^3 6 km offshore, and decreasing further offshore. The zooplankton were numerically dominated

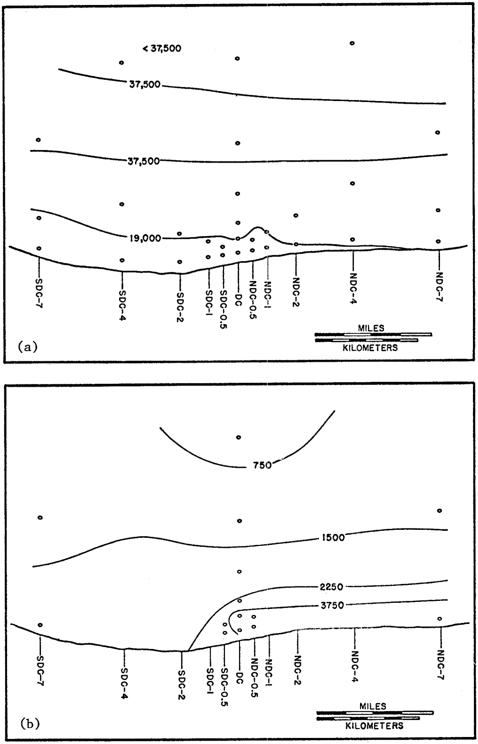


FIG. 21. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected 22 August 1974. (a) Total zooplankton; (b) nauplii.

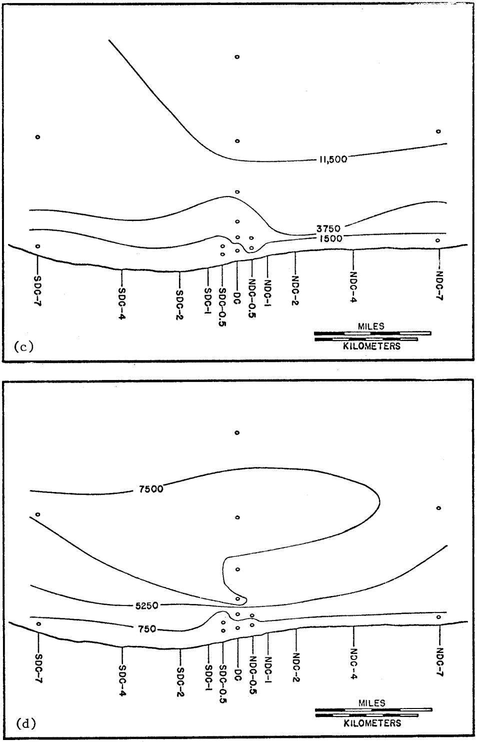
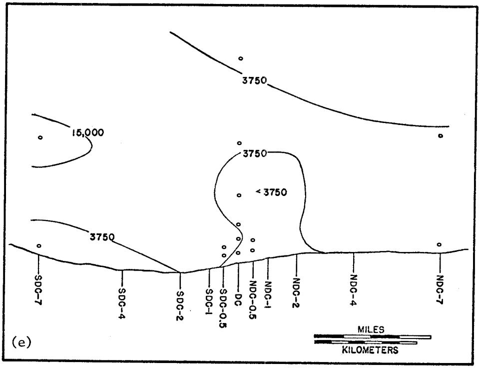


FIG. 21 continued. (c) Immature *Diaptomus* spp. copepodites; (d) adult *Cyclops* spp.



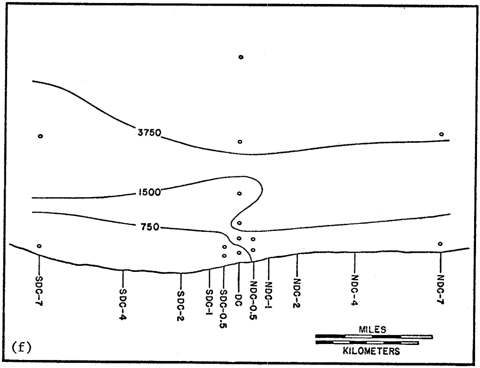


FIG. 21 continued. (e) *Bosmina longirostris;* (f) *Daphnia* spp.

by the copepods.

August was a period of continued copepod reproduction. Nauplii (Fig. 21b) were more abundant than in July, with maximum abundances of over $4,000/m^3$ within 1 km of shore and north of the plant and decreasing with distance offshore to less than $670/m^3$ at DC-6.

August was the first month in which *Diaptomus* spp. were more abundant than *Cyclops bicuspidatus*. The dominant species were *D. ashlandi* and *D. minutus*, the former relatively more abundant within 1-3 km of shore and the latter relatively more abundant offshore. *Diaptomus* spp. adults were less abundant than in July--less than $1,600/m^3$ within the inner 5-6 km of shore and over $1,600/m^3$ further offshore. Immature *Diaptomus* copepodites (Fig. 21c) occurred in similar numbers in July and August over most of the survey area; they were more abundant 8 km offshore in August than in July. Copepodites increased in abundance with distance offshore from less than $1,600/m^3$ within 1 km of shore to a maximum of $16,000/m^3$ 8 km offshore.

Cyclops spp. adults were less abundant than in July. There were less than $50/m^3$ within 1 km of shore, and maximum concentrations of $1,200$-$2,400/m^3$ were located 1-10 km offshore. Both *C. bicuspidatus* and *C. vernalis* were collected although the latter species was comparatively rare. Immature copepodites (Fig. 21d) were also less abundant. There were less than $800/m^3$ within 1 km of shore; further offshore the concentration increased to a maximum of $8,000$-$10,250/m^3$.

Many of the other species of copepods were more abundant. *Epischura lacustris* occurred mainly as immatures; concentrations varied from less than $500/m^3$ within 1 km of shore to over $1,600/m^3$ 8-11 km offshore. Conversely, *Eurytemora affinis* was most abundant (400-$2,400/m^3$) within 1 km of shore and less abundant further offshore; it was apparently reproducing at this time as both adults and immatures were collected. *Tropocyclops prasinus mexicanus* was most abundant (500-$1,000/m^3$) 1-6 km offshore; this species was reproductive and immatures and adults were collected. The increase in abundance of nauplii was probably associated with the increased reproductive activity of *Epischura lacustris*, *Eurytemora affinis*, and *Tropocyclops prasinus mexicanus*;

Diaptomus spp. and *Cyclops bicuspidatus*, while reproducing, were less abundant than in July.

The cladoceran *Bosmina longirostris* became relatively less abundant while other genera became more abundant. Within 1 km of shore *B. longirostris* (Fig. 21e) was approximately as abundant (2,400-10,000/m^3) as in July. Offshore it was considerably less abundant and attained a maximum concentration of 18,000/m^3 at SDC 7-5 in comparison with a maximum concentration of 114,550/m^3 at DC-4 in July.

Eubosmina coregoni was more abundant. Concentrations were less than 100/m^3 within 1 km of shore; maximum concentrations of 1,200-2,700/m^3 were located 6-8 km from shore.

Daphnia spp. were also more abundant. The dominant species was *D. retrocurva*. *Daphnia* spp. (Fig. 21f) increased in abundance with distance offshore from less than 800/m^3 within 1 km of shore and south of the plant to 4,000-5,800/m^3 8-11 km offshore.

Many other species of cladocerans were collected in increased numbers. *Ceriodaphnia quadrangula* was most abundant 5-8 km offshore and occurred in concentrations of over 300-800/m^3. *Chydorus sphaericus* occurred in maximum concentrations of 40-95/m^3 north of the plant and 1-11 km offshore. *Diaphanosoma leuchtenbergianum* was most abundant (40-90/m^3) 6 km offshore. *Holopedium gibberum* was also most abundant (470-950/m^3) 6 km and further offshore. The carnivore *Leptodora kindtii* occurred sporadically in low numbers over the survey grid (50/m^3). *Polyphemus pediculus* was most abundant (25-150/m^3) within 3 km of shore, in contrast with July when *P. pediculus* was most abundant offshore.

Asplanchna spp. were more abundant. Within 1 km of shore, the rotifers occurred in concentrations of 500-1,500/m^3 and then decreased with distance offshore to less than 80/m^3 10 km from shore.

Short Survey, 12 September 1974

The concentration of total zooplankton was similar to that in August. However, there was a difference in the species composition, with *Diaptomus* spp. and *Cyclops* spp. being relatively more abundant among the copepods and *Bosmina longirostris* becoming relatively more dominant

among the cladocerans. The abundance of total zooplankton (Fig. 22a) varied from less than $16,000/m^3$ within 1 km of shore to a maximum of $40,000-50,000/m^3$ 6-10 km offshore.

The zooplankton were dominated by the copepods, with immature copepodites being the most abundant stage. Nauplii were less abundant than in August. Maximum concentrations of $1100-2400/m^3$ were located inshore, and concentrations decreased to $700-1,300/m^3$ offshore.

Diaptomus spp. were less abundant than in August. The dominant species were *D. ashlandi* and *D. minutus* although *D. oregonensis* and *D. sicilis* also occurred. *Diaptomus* spp. adults were less abundant (less than $400/m^3$) within 1 km of shore and increased with distance offshore to a maximum of $1,900/m^3$ at DC-5. Immatures (Fig. 22b) were also less abundant. Maximum concentrations were over $9,500/m^3$, located 8-11 km offshore. The lowest concentration of immatures (less than $1,600/m^3$) occurred within 1 km of shore.

Cyclops spp. adults were more abundant. Concentrations (Fig. 22c) were minimal (less than $100/m^3$) within 1 km of shore and greatest ($3,200-4,300/m^3$) 5-10 km offshore. The dominant species was *C. bicuspidatus* with *C. vernalis* being less abundant. Immature *Cyclops* spp. copepodites were also more abundant. Concentrations (Fig. 22d) of less than $3,200/m^3$ were found within 1 km of shore and maximum concentrations ($13,000-14,000/m^3$) 5-8 km offshore. *Cyclops bicuspidatus* was more numerous than *Diaptomus* spp.

The other species of copepods accounted for a smaller percentage of the total zooplankton than in August. *Epischura lacustris* was present but occurred in concentrations of less than $160/m^3$ over most of the survey area. *Eurytemora affinis* was less abundant ($16-300/m^3$) than in August, as was *Tropocyclops prasinus mexicanus* ($24-400/m^3$). All three of these species were reproductively active.

The cladoceran *Bosmina longirostris* (Fig. 22e) was more abundant than in August; within 1 km of shore there were $5,200-13,000/m^3$. Minimum concentrations of less than $4,700/m^3$ were found in two patches, one 1-5 km offshore and the second 10-11 km offshore.

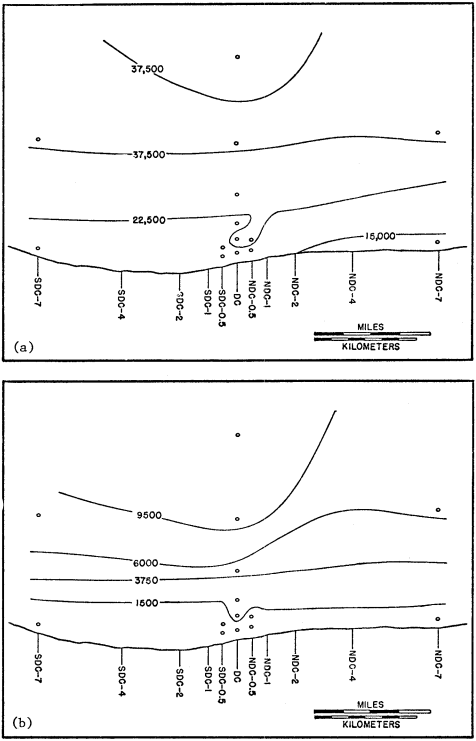


FIG. 22. Horizontal distributions (numbers/m^3) of total zooplankton and major zooplankton taxa collected on 12 September 1974. (a) Total zooplankton; (b) immature *Diaptomus* spp. copepodites.

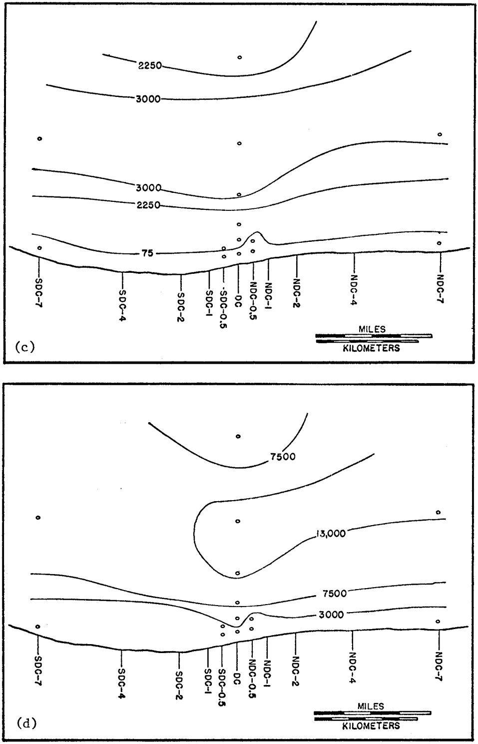
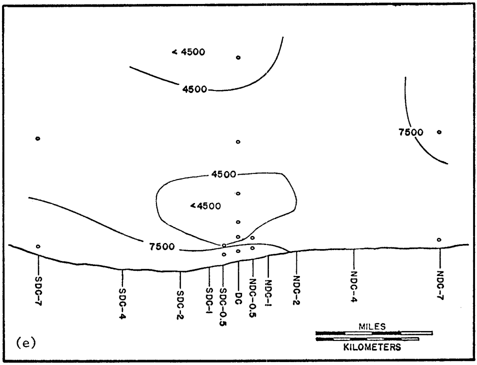


FIG. 22 continued. (c) Adult and (d) immature *Cyclops* spp. copepodites.



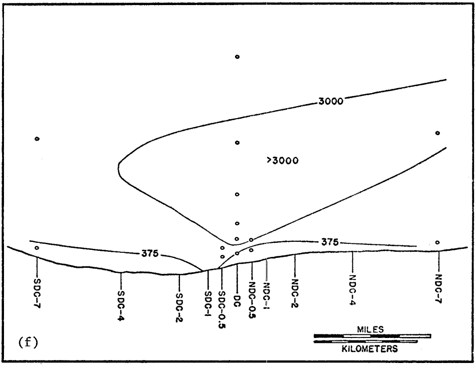


FIG. 22 continued. (e) *Bosmina longirostris;* (f) *Daphnia* spp.

Daphnia spp. (Fig. 22f) were approximately as abundant as in August; *D. retrocurva* was the dominant form. Densities of less than $40/m^3$ were associated with most of the inshore water. Maximum concentrations ($<9,000/m^3$) of *Daphnia* spp. occurred 1-10 km offshore.

Ceriodaphnia quadrangula was less abundant (less than $160/m^3$) than in August. *Chydorus sphaericus* was more abundant but did not occur in concentrations above $110/m^3$. *Eubosmina coregoni* ($160-700/m^3$) and *Holopedium gibberum* ($55-240/m^3$) were less abundant while *Leptodora kindtii* ($16-47/m^3$) was slightly more abundant.

Asplanchna spp. were more abundant. Concentrations were over $1,200/m^3$ within 1 km of shore and decreased with distance offshore to $400/m^3$ at DC-6.

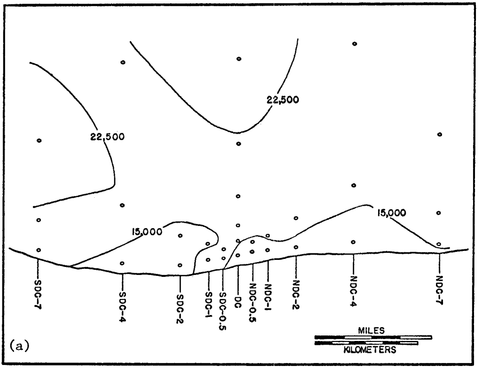
Major Survey, 9 October 1974

The abundance of total zooplankton was less than in September. Over most of the inshore area there were fewer than 16,000 zooplankton (Fig. 23a) per cubic meter. The copepods dominated the zooplankton although the cladoceran *Eubosmina coregoni* was also an important member of the fauna. Offshore, zooplankton concentrations ranged from $16,000-36,000/m^3$.

Nauplii continued to decline in numbers through October, occurring in abundances of $400-1,600/m^3$ over the survey area.

Diaptomus spp. adults were less abundant than in September; dominant species were *D. ashlandi* and *D. minutus*. *Diaptomus* spp. were generally less abundant (fewer than $400/m^3$) within 1-5 km of shore and more abundant (over $550/m^3$) further offshore. Immature copepodites (Fig. 23b) were approximately as abundant as in September. There were $4,000/m^3$ within 1 km of shore and $8,000-16,000/m^3$ further offshore.

Cyclops spp. adults were less numerous, with less than $1,000/m^3$ within 3 km of shore. Maximum densities of over $1,600/m^3$ were found 1-8 km offshore and south of the plant. *C. bicuspidatus* was the dominant species while *C. vernalis* was rare. Immature *Cyclops* spp. copepodites were also less abundant and occurred (Fig. 23c) in concentrations of less than $3,200/m^3$ within 1 km of shore and $6,400-10,250/m^3$ offshore.



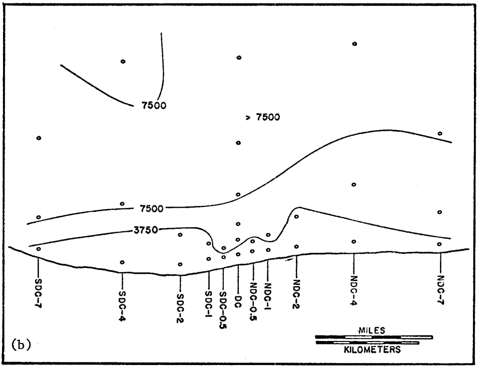


FIG. 23. Horizontal distributions (numbers/m^3) of total zooplankton and of major zooplankton taxa collected on 9 October 1974. (a) Total zooplankton; (b) immature *Diaptomus* spp. copepodites.

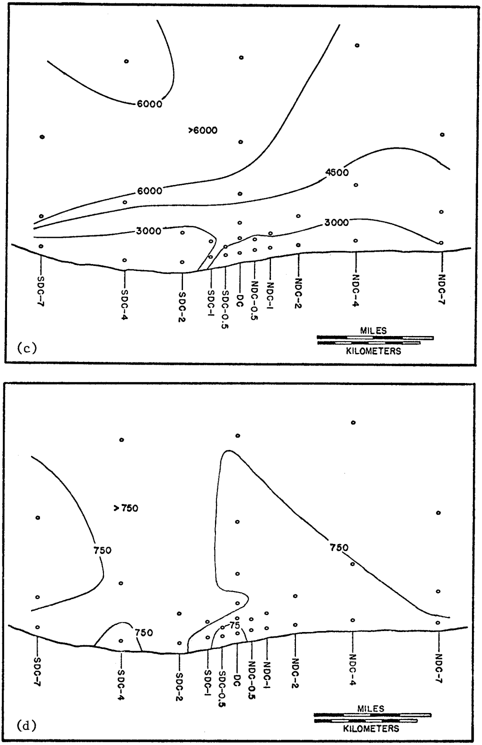


FIG. 23 continued. (c) Immature *Cyclops* spp. copepodites; (d) adult *Tropocyclops prasinus mexicanus*.

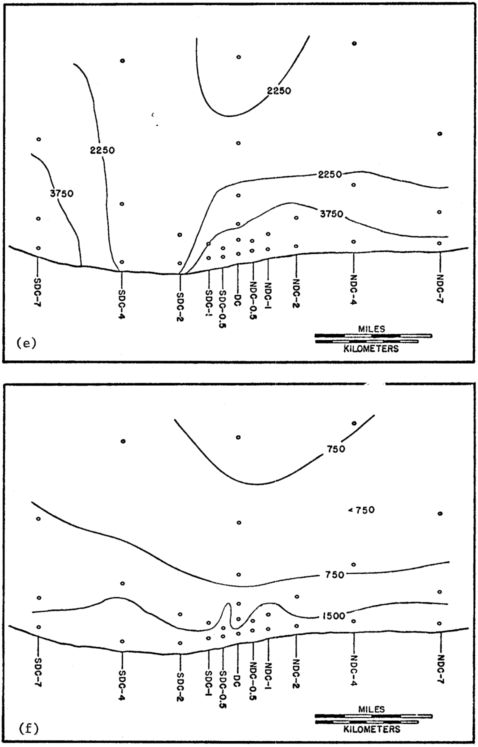


FIG. 23 continued. (e) *Daphnia* spp; (f) *Eubosmina coregoni*.

Cyclops bicuspidatus was more numerous than *Diaptomus* spp.

The other species of copepods were less abundant than either *Cyclops bicuspidatus* or *Diaptomus* spp. *Epischura lacustris* was more abundant than in September occurring as immatures and adults in concentrations of 80-1,500/m^3 with the highest abundances occurring offshore. *Eurytemora affinis* adults and immatures were as abundant as in September; there were less than 80/m^3 within 1 km of shore and they became less abundant with increasing distance offshore. *Tropocyclops prasinus mexicanus* (Fig. 23d) occurred mainly as adults and was considerably more abundant than in September. Concentrations ranged from 400-1,600/m^3.

The cladoceran *Bosmina longirostris* was less abundant (50-800/m^3) than in September. Conversely, *Eubosmina coregoni* (Fig. 23e) was more abundant. Maximum concentrations of 1,600-4,500/m^3 were associated with the water within 1 km of shore, becoming less abundant (300-1,650/m^3) further offshore.

Daphnia (Fig. 23f) was the dominant cladoceran genus; *D. retrocurva* was the most abundant species although large numbers of *D. galeata mendotae* also occurred. *Daphnia* spp. occurred in densities of 950-8,400/m^3.

Holopedium gibberum and *Chydorus sphaericus* (<52/m^3) were less abundant while *Leptodora kindtii* (25-200/m^3) was more abundant. *Asplanchna* spp. (0-160/m^3) were less abundant.

19 November 1974 (Table 1)

A lake survey was not made in November as poor weather and rough lake conditions prevented the RV/MYSIS from leaving port. However, entrainment samples were collected in this month, from which estimates have been made of the abundance and species composition of zooplankton in the vicinity of the intake structures (approximately between DC-1 and DC-2). The abundance of total zooplankton was 9,969/m^3, approximately the same as that in October.

The zooplankton were dominated by copepods. Nauplii were not abundant (472/m^3), accounting for less than 5% of the zooplankton. Adult *Diaptomus* spp. occurred in concentrations of 2,329/m^3; *D. ashlandi, D. minutus* and *D. oregonensis* were abundant while *D. sicilis* was rare.

TABLE 1. Mean abundances, standard errors of the mean, coefficients of variation and percentage compositions of zooplankton collected on 19 November 1974. (MTR 1-6 at 18 ft in the forebay of the screen house.)

Taxa	Mean #/m^3	$S_{\bar{x}}$	C.V.	% comp.
Copepod nauplii	472	234	86	4.7
Cyclops C1-C5	3830	1012	46	38.4
Cyclops bicuspidatus C6	367	101	48	3.7
Tropocyclops prasinus mexicanus	71	8	20	0.7
Diaptomus C1-C5	1820	602	57	18.3
Diaptomus ashlandi C6	982	103	18	9.9
Diaptomus minutus C6	447	197	76	4.5
Diaptomus oregonensis C6	459	150	57	4.6
Diaptomus sicilis C6	261	78	52	2.6
Epischura C1-C5	21	11	92	0.2
Epischura lacustris C6	17	4	41	0.2
Eurytemora affinis C6	4	4	173	0.0
Bosmina longirostris	350	61	61	3.5
Chydorus sphaericus	4	4	173	0.0
Daphnia longiremus	4	4	173	0.0
Daphnia galeata	109	15	24	1.1
Daphnia retrocurva	93	37	69	0.9
Eubosmina coregoni	556	241	75	5.6
Holopedium gibberum	13	13	173	0.1
Asplanchna spp.	88	34	66	0.9
Total	9969	2474	46	

Immature copepodites accounted for 20% of the zooplankton and occurred in concentrations of $1,820/m^3$. *Diaptomus* spp. adults were probably reproductive but at a lower rate than in the spring or summer.

Cyclops bicuspidatus was less abundant as adults ($367/m^3$) than as immature copepodites ($3,830/m^3$). The immatures were mainly in the fourth copepodite stage (Fig. 24a) although other developmental stages were also present; *C. bicuspidatus* may have been reproducing but at a very low rate.

Tropocyclops prasinus mexicanus was present ($71/m^3$) only in the adult stage and was not reproductively active. *Epischura lacustris* immatures were present ($38/m^3$). *Limnocalanus macrurus* was not collected in the November samples although the cold water inhabiting *Diaptomus sicilis* was collected at this time.

Cladocerans formed only a small component of the total zooplankton. The dominant form was *Eubosmina coregoni* ($556/m^3$); *Bosmina longirostris* ($350/m^3$) and *Daphnia* spp. ($206/m^3$) were also collected. *Chydorus sphaericus, Holopedium gibberum, Leptodora kindtii,* and *Asplanchna* spp. were occasionally captured.

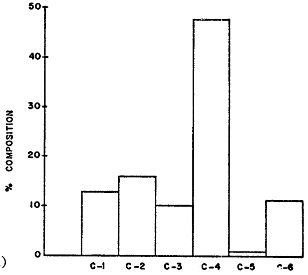
30 January 1975 (Table 2)

An entrainment study was made in January. Total zooplankton abundances were estimated at $6,178/m^3$, and were dominated by the copepods. Nauplii were rare ($17/m^3$) and accounted for less than 1% of the zooplankton. *Diaptomus* spp. adults occurred in concentrations of $1,333/m^3$ and accounted for approximately 22%. The most abundant species was *D. ashlandi*, followed by *D. minutus, D. sicilis* and *D. oregonensis*. Immatures accounted for 8% of the zooplankton.

Cyclops bicuspidatus adults were relatively rare ($296/m^3$) and accounted for less than 5% of the zooplankton. Immatures were more abundant ($3,938/m^3$); a large fraction were in the fourth copepodite stage (Fig. 24b). There were relatively more fifth copepodites than in November.

Limnocalanus macrurus, Eurytemora affinis, and *Epischura lacustris* were not observed. *Tropocyclops prasinus mexicanus* and *Canthocamptus* sp. were collected in low numbers.

(a)



(b)

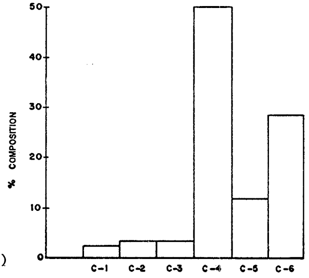


FIG. 24. Percentage composition of copepodite stages of *Cyclops bicuspidatus* on (a) 19 November 1974 and on (b) 30 January 1975 in zooplankton samples collected from the forebay of the Cook power plant.

TABLE 2. Mean abundances, standard errors of the mean, coefficients of variation and percentage compositions of zooplankton collected on 30 January 1975. (M7R 1-7 at 18 ft in the forebay of the screen house.)

Taxa	Mean #/m^3	$S_{\bar{x}}$	C.V.	% comp.
Copepod nauplii	17	9	96	0.3
Cyclops C1-C5	3938	578	25	63.7
Cyclops bicuspidatus C6	296	139	81	4.8
Tropocyclops prasinus mexicanus C6	24	12	84	0.4
Diaptomus C1-C5	94	94	31	8.4
Diaptomus ashlandi C6	1063	404	66	17.2
Diaptomus minutus C6	197	51	45	3.2
Diaptomus oregonensis C6	8	8	173	0.1
Diaptomus sicilis C6	65	30	81	1.1
Limnocalanus macrurus C6	13	3	35	0.2
Canthocamptus sp. C6	3	3	173	0.1
Bosmina longirostris	8	8	2	0.1
Daphnia galeata	4	4	2	0.1
Eubosmina coregoni	24	16	1	0.4
Total	6178	1185	33	

The cladocerans were less abundant than in November. *Eubosmina coregoni* (24/m^3) was more abundant than *Bosmina longirostris* (8/m^3). *Daphnia* spp. (4/m^3) were rare. *Asplanchna* spp. were not captured.

DISCUSSION

Data collected during the 1974 survey cruises give information on the seasonal occurrences of the various zooplankton species and their spatial patterns of distribution. A more detailed analysis and discussion are given in Section 3.

The temporal distribution of zooplankton over the 12-month year can be roughly grouped into four seasons--winter, spring, summer, and autumn. In this text, winter is considered to extend from December to February, spring from March to May, summer from June to August, and autumn from September to November.

Winter

Winter is a period of heat loss from the lake. During this season the lake loses heat to the overlying atmosphere, and water temperatures approach 0°C. The water is isothermal and easily mixed to depths of several decameters.

Winter is a harsh period for most life forms. Many species of phytoplankton form auxospores and survive through the winter in a dormant state. Some species are metabolically active, but reproductive rates are generally low and the standing stock of phytoplankton is small. Phytoplankton are generally limited in their growth by the low water temperatures and the reduced number of daylight hours. The intensity of light is also low in the winter. During this season, dissolved nutrients are probably not limiting to phytoplankton.

Winter can be a harsh time for the zooplankton. In October 1973 the mean abundance of zooplankton was $28,810/m^3$ (Stewart 1974); by April 1974 there were only $3,047/m^3$ (Fig. 25). These data indicate a large decline in zooplankton abundances over the winter. Food availability may be the most serious limiting factor to zooplankton survival.

Zooplankton may survive through the winter in several ways. Some forms such as the cladocerans produce resting eggs and the species survives through the winter in a metabolically dormant state. Adults may also be present in the plankton although in low numbers. *Daphnia galeata mendotae*, *D. retrocurva*, *D. longiremis*, *Bosmina longirostris*, and *Eubosmina coregoni* have all been collected in January (Fig. 26) although they accounted for less than 2% of the plankton. Some cladocerans were observed carrying eggs and so some reproduction must have occurred although at a low rate.

In 1974 and 1975 the dominant zooplankton were the copepods. *Diaptomus* spp. were the dominant calanoid species and formed approximately 25% of

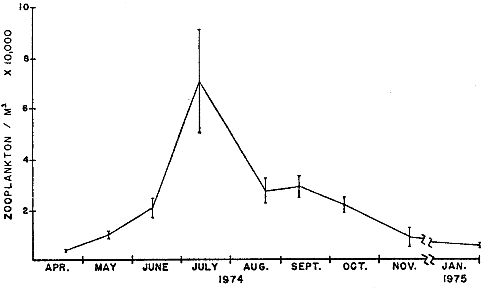


FIG. 25. The mean concentration and standard error of the various taxa of zooplankton along the DC-transect from April to October 1974 and in the intake waters of the power plant during November 1974 and January 1975.

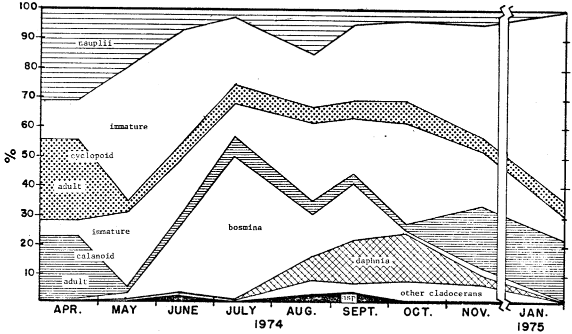


FIG. 26. The average percent composition of the various taxa of zooplankton along the DC-transect from April to October 1974 and in the intake waters of the power plant during November 1974 and January 1975.

the zooplankton (Fig. 26); *D. ashlandi, D. minutus, D. oregonensis,* and *D. sicilis* were all present. Winter was the only season in which *D. sicilis* was observed in the inshore waters. *Diaptomus* spp. occurred mainly in the adult stage throughout the winter and were reproductively active. Immature copepodites were present and more abundant than the nauplii. However, as the time spent in the nauplius stage may be considerably shorter than the time spent in the copepodite stages, these differences in relative abundance are not necessarily unexpected.

The other abundant copepod was the cyclopoid *Cyclops bicuspidatus*. This species passed the winter in intermediate copopodite stages, with most of the immatures being in the fourth stage. This has been observed before in other areas (McQueen 1969; Carter 1974). This pattern of arrested development has also been observed in some species of marine calanoid copepods (Marshall and Orr 1972). A few adults were present in the winter and these may have been reproductively active.

Tropocyclops prasinus mexicanus was captured occasionally during the winter. Unlike *C. bicuspidatus, T. prasinus* spent the winter in the adult stage; it was not reproductively active.

Spring

Spring is a season of net heat input into the lake. The overlying air is comparatively warm and the surface of the lake is warmed. The water column is unstable at this time and mixing occurs to several meters. In the early part of the spring, the water column is thermally unstratified and heat added to the surface of the lake is quickly transferred throughout the water column. Towards the end of spring, the water becomes slightly stratified. The most intense warming of the water occurs in the shallow nearshore regions of the lake where the temperature of the heated water is less effectively reduced by mixing with the cold bottom water.

With increasing water temperatures and increasing number of daylight hours, there is an increase in primary production and in the standing stock of phytoplankton. The inshore waters are a particularly favorable region where the shallowness of the water column tends to prevent the phytoplankton from being mixed below their critical depth.

In the spring there is an increase in the standing stock of zooplankton (Fig. 25). Higher water temperatures and increased food supply to herbivores such as *Diaptomus* spp., *Bosmina longirostris* and *Daphnia* spp. enable these zooplankton to maintain higher metabolic rates. At these times, there is an increase in reproductive activity.

In 1974 the dominant spring zooplankton were the copepods (Fig. 26). *Cyclops bicuspidatus* was the most abundant species followed by *Diaptomus* spp. The most common species was *D. ashlandi* followed by *D. minutus* and *D. oregonensis*; *D. sicilis* was rare and was not found in the inshore waters. *Epischura lacustris, Eurytemora affinis,* and *Limnocalanus macrurus* were present in low numbers and were reproductively active. *Tropocyclops prasinus mexicanus* was present only as the adult and was not breeding at this time.

Cladocerans formed only a small fraction of the total zooplankton (Fig. 25) although they increased both in numbers and relative abundance as spring progressed. *Bosmina longirostris* and *Daphnia* spp. were the dominant forms.

Summer

Summer is a season of continued heat input into the lake. Surface water temperatures are generally highest close to shore and decrease with distance offshore. During the summer the water column is thermally stratified, and as a result it has a great deal of physical stability and is resistant to vertical mixing. This leads to two phenomena. First, the heat input at the surface is transferred into a relatively few meters of the water column, which results in a warm epilimnion layer and a cold hypolimnion layer. This results in an intensification of the thermal stratification, which continues to increase over the summer as long as heat continues to be put into the lake at the surface. The thermal stratification also presents a barrier to the movement of nutrient-rich hypolimnetic water into the epilimnion.

The standing stock of phytoplankton is often low in the summer. Phytoplankton may be nutrient-limited at various times, and this plus the intense grazing pressure exerted by the zooplankton tends to prevent the

phytoplankton standing stock from being as great as in the spring or autumn.

Upwellings occur in the summer, bringing nutrient-rich water to the surface in the inshore area. At these times there may be an increase in primary production and in the standing stock of phytoplankton, and distributions of the zooplankton and fish may be altered.

Zooplankton increased in abundance (Fig. 25) through the summer of 1974. The copepods *Diaptomus* spp. and *Cyclops bicuspidatus* were reproductive; nauplii, immature copepodites and adults increased in numbers from May through June and July. In August these species were somewhat less abundant. *Epischura lacustris* and *Eurytemora affinis* were reproductive throughout the summer and were particularly abundant in August. During this month they may have exerted significant competitive pressure on *Cyclops bicuspidatus* and *Diaptomus* spp. *Epischura lacustris* and *C. bicuspidatus* are both omnivores (Main 1962; McQueen 1969) and may compete for similar plant or animal food organisms. *Diaptomus* spp. and *Eurytemora* spp. are probably both filter feeders and consume plant cells less than 20μ in diameter (Gliwicz 1969). *Tropocyclops prasinus mexicanus* was present in the adult stage through the summer and did not breed until August.

The cladocerans were abundant in the summer and increased both in numbers and relative abundance (Fig. 26) during June and July; in August they began to decline in numbers. *Bosmina longirostris* was the dominant cladoceran and occurred in maximum numbers in July; *Daphnia* spp. and *Eubosmina* were the next most abundant. In August, *Bosmina longirostris* declined in abundance, while *Daphnia* spp. and *Eubosmina coregoni* became relatively more abundant. Several other species of cladocerans became abundant in August, i.e. *Chydorus sphaericus, Ceriodaphnia quadrangula, Holopedium gibberum, Leptodora kindtii,* and *Polyphemus pediculus*. The reason (or reasons) for the increase both in copepod and cladoceran diversity in August has (have) not yet been investigated.

Autumn

Autumn is a period in which there is heat loss from the lake to the atmosphere. The thermal stratification of the water column is reduced through the season until the water becomes isothermal. The most rapid cooling takes place in the inshore waters.

During this season there may be an increase in primary production and in the standing stock of phytoplankton as nutrient-rich waters are mixed back into the surface waters. While the standing stock of zooplankton is high, it is generally lower than that of the summer months (Fig. 26); therefore, there is probably a reduction in the grazing pressure on the phytoplankton.

The standing stock of zooplankton was reduced through the autumn of 1974 (Fig. 25), although the zooplankton were more abundant than in the early months of the spring. The major decrease in numbers was associated with the decline in the abundance of the cladocerans, especially *Bosmina longirostris*. Other species of cladocerans were abundant in the early autumn but, apart from *Eubosmina coregoni* and *Daphnia* spp., they became rare by late autumn (Fig. 26). During the autumn, sexual rather than parthenogenetic reproduction became the more common, and ephippial eggs were produced which enabled many of the species of cladocerans to survive through the winter in an inactive state.

The copepods *Diaptomus* spp. and *Cyclops bicuspidatus* became increasingly dominant components of the zooplankton (Fig. 26) as the autumn progressed. These species and *Eurytemora affinis, Epischura lacustris* and *Tropocyclops prasinus mexicanus* were all reproductively active in September. By November, *Tropocyclops prasinus mexicanus* had ceased breeding. *Diaptomus* and *Cyclops bicuspidatus* may have been reproductive but at very low rates; *C. bicuspidatus* occurred mainly in the fourth copepodite stage and apparently spent most of the late autumn and early winter in this stage.

SUMMARY AND CONCLUSIONS

The spring, summer and fall seasonal patterns of abundance described above have been observed consistently during the years of the preoperational

study. Initial analyses have determined the dominant zooplankton taxa for each month and each season. However, these dominants exhibit large variations in abundance from one year to the next, and from one location to another over the survey grid. Further analyses need to be made of the spatial variation in zooplankton abundance and of the year-to-year variations in abundance.

SECTION 3

AN EXAMINATION OF THE SPATIAL HETEROGENEITIES IN THE DISTRIBUTION OF ZOOPLANKTON DURING THE MAJOR SURVEY CRUISES

by Marlene S. Evans and Bethany E. Hawkins

INTRODUCTION

In February 1975, the Cook Nuclear Power Plant began withdrawing water from Lake Michigan, heating it during condenser passage, and discharging it back into the lake as a thermal plume. Preliminary studies (Ayers and Huang 1967; Ayers et al. 1967) have predicted that in the spring, summer, and autumn the plume will tend to flow parallel to the shore in a northerly or southerly direction. In the winter, effluent water may flow offshore in a sinking plume.

Data collected during the survey cruises in April to November 1975 will be analyzed to determine whether or not there are any changes in abundance and species composition of the various components of the zooplankton community. As in each month the thermal plume will be located over only part of the survey grid, the area outside the plume could serve as the control region for the purposes of any statistical analysis. If analyses were made on such a grouping of stations, the underlying assumption would be that in the absence of the plume all the zooplankton would be homogeneously distributed over the survey area.

There are *a priori* reasons for assuming that zooplankton are not homogeneously distributed over the survey area. The survey grid lies within a physically non-uniform area, and heterogeneities in the physical environment are likely to lead to heterogeneities in the biotic environment.

Depths are not constant over the survey area but increase with distance offshore from 4 m at the shallowest station to over 40 m at the deepest stations. The temperature of the lake water and its thermal structure is closely related to the depth of the water column, and so there are frequently inshore-offshore differences in lake temperatures.

The waters in the survey area originate from several regions and

may be present in different proportions at various times of the year. Some water originates from the north and may contain a mixture of water from the St. Joseph River. Waters from the south may contain some input of effluents from areas such as Michigan City and Gary, Indiana. Along the shore of the survey area, towns such as Bridgman and Stevensville discharge waters of varying quality into the lake. Waters from offshore areas of the lake may flow inshore and into the survey area during upwellings.

The water flow is complex in the survey area. While water tends to flow north or south and parallel to the shore, there is some exchange in the inshore-offshore direction. The Michigan City-Benton Harbor eddy may lie in the survey area in the spring, summer, and autumn and this may add further complexity to the region. Current velocities vary in direction and speed with depth and over different areas of the survey grid (Ayers and Huang 1967; Ayers et al. 1967).

Preliminary analyses by Ayers (1975) have suggested that there may be inshore-offshore differences in the abundance of phytoplankton. Studies conducted by Mozley (1973, 1974) and Johnston (1973) have indicated that the benthos vary in abundance and species composition with distance offshore; there may also be differences in the species composition of benthos north and south of the power plant. The fish community varies in abundance and species composition with distance offshore (Jude et al. 1975) and there may be differences in the abundances of various species north and south of the plant. Preliminary observations made on the zooplankton distributions in 1972 (Roth 1973), 1973 (Stewart 1974), and 1974 (Section 2, this report) have noted inshore-offshore differences in zooplankton species composition and abundances.

As preliminary examinations of the preoperational data had indicated that zooplankton are not homogeneously distributed over the survey area, more rigorous statistical analyses were performed to investigate the spatial heterogeneity in zooplankton distributions. This was initially done for the major survey cruises of April, July, and October 1974 and the results are reported here.

METHODS

Principal component analyses were performed on data collected during the 1974 major survey cruises. The analyses were made using data transformed by $y = \log(x+1)$, where x is the number of animals/m^3; the Amdahl 470V/6 computer at the University of Michigan Computing Center was used to perform the analyses. The theory of principal component analysis is discussed in Morrison (1967) and Cooley and Lohnes (1971). It is a useful method for analyzing multidimensional correlations between different taxa in order to group stations with similar patterns of zooplankton abundances. Twenty-eight stations and 13 taxa were examined for the April cruise, 30 stations and 13 taxa for the July cruise, and 30 stations and 22 taxa for the October cruise. Results of the analysis for each cruise are presented, followed by a discussion. A general discussion and summary follow these analyses.

ANALYSIS OF THE APRIL SURVEY CRUISE DATA

Results

Figure 27 shows the scatter diagram produced as part of the computer printout. The X-axis is the first and the Y-axis the second principal component; each dot represents a particular station location with its unique values of pc_1 and pc_2. The first and second principal components accounted for 40.1% and 32.1% respectively of the total variance.

The interpretation of the scatter diagram was, to some extent, subjective. The diagram was viewed as consisting of three clusters. One group included the stations within the 5-10 m depth contours (with the exception of NDC 4-4 and NDC 7-1); this was called the inshore zone (Fig. 28). The second group included stations outside the 5-10 m but inside the 15-20 m depth contours (with the exception of NDC 4-4); this was called the midshore zone. The third group included all stations outside the 15-20 m depth contours and at least as far as the 40-m depth contour (with the exception of NDC 7-1); this was called the offshore region.

The mean abundance, standard deviation, and percentage composition of the 13 taxa used in the analysis are shown in Table 3 for each of the

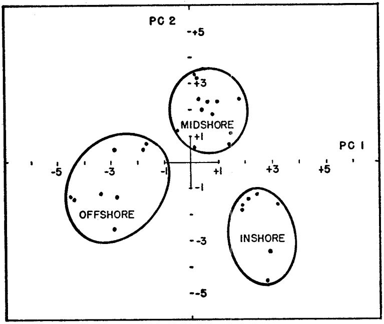


FIG. 27. Plot of stations against the first and second principal components, showing the three zones produced by the principal component analysis of the 20 April 1974 survey cruise data.

three zones. Also shown are the mean abundance and standard deviation for total zooplankton. The standing stock of zooplankton was lowest in the inshore region (980/m^3). Zooplankton increased sharply in abundance in the midshore region (3,414/m^3) and increased slightly in the offshore region (3,970/m^3). Zooplankton genus composition was similar in all three regions. Cladocerans and the rotifer *Asplanchna* spp. were rare in all zones but slightly more abundant in the midshore zone. Copepods were abundant, and three of the five genera examined had large inshore-offshore differences in abundance. Dominant copepods were *Cyclops* spp. (mainly *Cyclops bicuspidatus*) and *Diaptomus* spp.

The inshore region was numerically dominated by nauplii. The immature copepodites of *Cyclops* spp. and *Diaptomus* spp. were also abundant; these stages and nauplii accounted for more than 82% of the zooplankton. In the midshore region, nauplii and immature copepodites, while more abundant than in the inshore region, accounted for only 69% of the zooplankton.

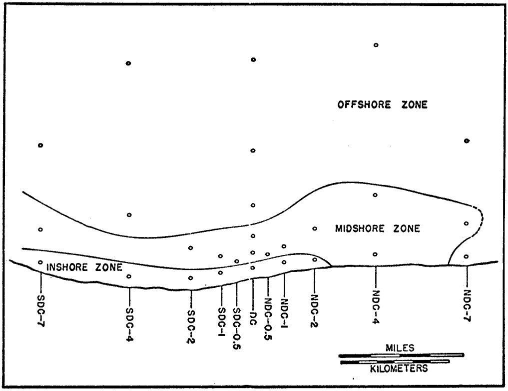


FIG. 28. The three zones determined from the results of the principal component analysis of the 20 April 1974 survey cruise data.

In the offshore region these taxa accounted for only 37% of the zooplankton and were less abundant than in the midshore region.

Adult *Diaptomus* spp. and *Cyclops* spp. accounted for only 12% of the zooplankton in the inshore region but for 60% in the offshore region. These taxa increased 7 and 22 times respectively in abundance from the inshore region to the offshore region; this increase was considerably larger than that observed for nauplii and immature *Diaptomus* spp. and *Cyclops* spp. in the three regions. Immature *Limnocalanus macrurus* copepodites were rare but also increased in abundance with distance offshore. *Eurytemora affinis* and *Tropocyclops prasinus mexicanus* were rare and had similar abundances in all three regions.

TABLE 3. Results of the principal component analysis of 20 April 1974 survey data showing the mean abundances, standard deviations of the mean, and percentage composition of zooplankton in the three zones. "Total zooplankton" refers to the abundance of all the zooplankton including those not used in the analysis. "n" refers to the number of stations in each zone.

	Inshore n=7			Midshore n=12			Offshore n=9		
Taxon	$\bar{x}$	s	%	$\bar{x}$	s	%	$\bar{x}$	s	%
Copepod nauplii	564	199	57.4	1564	501	45.8	857	663	21.1
Cyclops C1-C5	184	82	18.4	555	179	16.2	436	147	11.0
Cyclops C6	69	26	7.0	358	260	10.5	1533	525	38.7
Tropocyclops C6	18	6	1.8	22	11	0.6	45	24	1.1
Diaptomus C1-C5	61	24	6.2	233	71	6.8	184	51	4.9
Diaptomus C6	47	17	4.8	586	291	17.2	849	325	21.1
Eurytemora C1-C5	3	3	0.4	13	11	0.4	1	2	0.0
Limnocalanus C1-C5	1	1	0.1	21	17	0.6	49	26	1.2
Bosmina	17	6	1.8	29	12	0.9	9	10	0.2
Chydorus	1	2	0.2	4	2	0.1	1	2	0.0
Daphnia	6	5	0.6	16	6	0.5	2	3	0.0
Eubosmina	5	4	0.5	6	4	0.2	0	1	0.0
Asplanchna	3	7	0.3	5	7	0.1	0	0	0.0
Total zooplankton	980	331	-	3414	972	-	3970	1089	-

Discussion

Before interpretations should be made of the results of the principal component analysis of the April survey data, it is important to realize that the results are dependent upon the data input. In this analysis, 28 stations were separated into three regions on the basis of the distribution of 13 taxa of zooplankton at each station. Some of these 13 taxa had similar abundances at all stations, and had only these taxa been used in the analysis, the analysis would not have determined any discriminations between stations. Some of the 13 taxa (immature *Diaptomus* spp., *Limnocal*-

anus macrurus and adult *Cyclops* spp. and *Diaptomus* spp.) varied markedly in abundance from station to station; had only these taxa been used in the analysis, there would have been a sharper discrimination between stations, i.e., the first and second principal components would have accounted for more than 72.2% of the total variance.

The analysis of the April data considered many of the rare zooplankton, most of which accounted for less than 1% of the zooplankton at each station. These taxa exhibited only small inshore-midshore-offshore differences in abundances.

Despite the fact that many of the taxa used in the analysis did not exhibit large differences in abundance over the survey grid, the analysis indicated that the stations formed three distinct groups. The numerically dominant taxa all exhibited inshore-midshore-offshore differences in abundance. Interpretation of the results of the analysis will be based on the distributions on only the dominant taxa.

Two results of the principal component analysis were particularly interesting. The proportion of adult copepods to immature copepodites varied from 1:7.0 in the inshore region to 1:0.6 in the offshore region. The abundance of zooplankton was lowest in the inshore region and increased four-fold in the offshore region.

The inshore region was probably the most favorable for zooplankton growth and reproduction. The lake water was warmest close to shore (Section 1), and this would have increased the metabolic rate of the zooplankton, inducing rapid rates of reproduction and development. Primary production should have been greatest close to shore where the warm water, high nutrient levels, and shallowness of the water column (preventing phytoplankton from being mixed below their critical depth) would have favored rapid cell division rates.

The standing stock of phytoplankton was greatest close to shore; this is suggested by the low Secchi disc readings (Section 1) for that region. Published results form the eight short survey stations indicate that cell counts were highest close to shore (Ayers 1975). Unpublished data for the major survey indicate that cell counts varied from 1,000-4,500 cells/ml in the inshore area and decreased in abundance with

distance offshore to less than 1,000/ml 11 km offshore (Ayers, personal communication). Diatoms *Fragilaria* spp., *Asterionella* spp. and *Stephanodiscus* spp. accounted for more than 80% of the phytoplankton over most of the survey grid. Flagellates accounted for less than 20% of the phytoplankton at most stations; they formed up to 36% of the population in a few high density (600-750/ml) patches in the inshore and midshore areas (Ayers 1975; Ayers, personal communication).

While the abundance and taxa composition of the phytoplankton varied with distance offshore, there is no evidence that these differences were responsible for the differences in the abundance and species composition of the zooplankton. The phytoplankton standing stock was high, suggesting that the zooplankton were not food-limited. Zooplankton occurred in low numbers in the spring and were less likely to be food-limited than during the summer when the zooplankton standing stock had increased 10 to 20-fold and when primary production was reduced due to nutrient limitations.

Nauplii and cladocerans feed upon the ultraplankton and consume such food items as flagellates (Gliwicz 1969). While flagellates were less abundant in the offshore region than in the inshore and midshore regions, it is unlikely that nauplii were limited by the distribution of flagellates. Flagellates were more abundant than in July when large numbers of nauplii and cladocerans (7,000-155,000/m^3) dominated the plankton.

Cyclops spp. and *Diaptomus* spp. feed upon the nannoplankton and consume food items such as diatoms (Gliwicz 1969). Diatoms were slightly more abundant in the inshore (1,050-3,700/ml) and midshore regions (500-3,143/ml) than offshore (600-1,500/ml) (Ayers, personal communication). Conversely, the copepods were most abundant in the offshore region. Diatoms were probably not food-limiting to the copepods in April; these phytoplankton were approximately as abundant in April as in July when the diatoms supported a copepod standing stock of 2,400-37,000/m^3.

The physical and phytoplankton data suggest that the inshore region should have been the most favorable for zooplankton growth and reproduction. In fact it was, as this area was dominated by nauplii and the

immature copepodite stages of *Cyclops* spp. and *Diaptomus* spp.; adults therefore must have found this region favorable for reproduction. The absence of adults in the inshore area may have been due in part to the fact that adults may die after completing the reproductive process; the large number of adults in the offshore region could have been due to the fact that these organisms were not so far along in their life history and had not completed their breeding cycle. However, while this hypothesis may explain the relative differences in abundances between adult and immature copepods and nauplii in the three regions, it does not explain why most taxa of zooplankton (including immature copepods) were least abundant inshore.

During the spring the lake waters are warmed, with the inshore waters showing the most rapid increase in temperature. At this time many species of fish migrate inshore from the deeper portions of the lake where they overwinter. Some, such as the smelt, migrate inshore to spawn and then move offshore. Others, such as the alewife and spottail shiner, spend the spring and summer months in waters less than 10 m deep (Wells 1968). These three species were the numerically dominant fish in the survey area in April 1973 (1974 data not currently available); alewife accounted for 60%, spottail shiners for 23% and smelt for 15% of the total catch of fish (Jude et al. 1975).

Alewife are filter-feeding planktivores and consume the largest components of the zooplankton. *Cyclops bicuspidatus* and *Diaptomus* spp. have been observed in the stomachs of alewife collected from the littoral zone (Wells 1970). Adult smelt are primarily benthic feeders although they do consume zooplankton and apparently select the larger animals (Reif and Tappa 1966). Spottail shiners are planktivores throughout most of their lives (Scott and Crossman 1973); they are probably size-selective in their feeding with various forms of zooplankton being preferred at different stages in their life cycle (Griswold 1963; Smith and Kramer 1964; Basch 1968).

There is a great deal of evidence in the literature that planktivorous fish may alter the zooplankton species composition of a water body. Hrbáček and Novotná-Dvořáková (1965) eliminated the fish stock

from four backwaters in Czechoslovakia. During the following years, they observed a regeneration in the fish stock and, concomitant with this, a change in the zooplankton species composition. Large zooplankton which were present when the fish were absent gradually became reduced in numbers over the years and the smaller zooplankton became more abundant and dominated the zooplankton.

Several studies conducted in North America have also suggested that fish may selectively remove the largest components of the zooplankton with the result that the zooplankton becomes dominated by the smaller species. Reif and Tappa (1966) observed the replacement of *Daphnia pulex* by *D. dubia* and the loss of *Leptodora kindtii* when smelt were introduced to Harvey's Lake. Galbraith (1967) observed a similar shift to the smaller species of *Daphnia* in lakes inhabited by rainbow trout and yellow perch.

Brooks and Dodson (1965) and Brooks (1968) have shown that the presence of alewife in various small lakes in New England has apparently resulted in the disappearance of large zooplankton such as *Epischura nordenskioldi*, *Diaptomus minutus*, and *Mesocyclops edax* and in the dominance of small zooplankton such as *Tropocyclops prasinus* and *Bosmina longirostris*. The larger *Cyclops bicuspidatus thomasi* apparently was able to survive in the littoral zone because it remained on or near the bottom during the day and avoided predation. Brooks (1968) showed that the alewife feeds upon the largest components of the zooplankton and when these have been exhausted feeds upon successively smaller components of the zooplankton. In Lake Michigan, Wells (1970) described decreases in the abundance of the largest species of cladocerans and copepods and increases in the abundance of the medium and small-sized zooplankton from 1954 to 1966 during which time alewife increased markedly in numbers.

There is good circumstantial evidence that fish predation is the major factor responsible for the scarcity of the larger zooplankton (*Cyclops* spp., *Diaptomus* spp., *Limnocalanus macrurus* spp.) in the inshore region. There is a strong migration of alewife, smelt, and spottail shiners into the inshore region in the spring and their known food items

were generally sparse in this region in April 1974. Adult *Cyclops bicuspidatus* and *Diaptomus* spp. were 18-22 times less abundant in the inshore region than in the offshore region while the smaller immature copepodites increased only 2-4 times in abundance with distance offshore. The large immature copepodites of *Limnocalanus macrurus* increased in abundance from $1/m^3$ in the inshore zone to $63/m^3$ in the offshore zone. Small zooplankton such as nauplii, *Bosmina longirostris*, *Eubosmina coregoni*, *Chydorus sphaericus*, and *Asplanchna* spp. varied less in abundance with distance offshore. Therefore while Wells (1970) observed temporal changes in the composition of zooplankton due to the alewife, the results of the investigation of the April survey cruise data suggest that spatial changes in the distribution of zooplankton may also be due to alewife (and probably smelt and spottail shiners although to a lesser extent).

Preliminary analyses of several years of zooplankton and water temperature data have indicated that large numbers of adult copepods occurred inshore during the years in which the water was cold and fish migration was probably delayed. While the 1975 data are not complete, the temperature data indicate that April 1975 was a cold month and that the zooplankton did not exhibit large differences in their abundances over the survey grid. The cold water apparently delayed the inshore migration of smelt, alewife, and spottail shiners, for only low numbers of these organisms were collected during the week of the survey cruise (Jude, personal communication). This provides further circumstantial evidence that the concentration of fish within the 5-10 m depth contour is an important regulating factor of the abundance and species composition of the zooplankton.

The midshore region was apparently the most favorable for nauplius, copepodite, and possibly cladoceran growth and development. This may have been due to the balance between water temperatures, phytoplankton production, and fish predation. These three factors probably enabled adults to attain high reproductive rates and the immatures to maintain high survival rates.

The inshore-offshore differences in zooplankton abundance and species composition were maintained to some extent by the pattern of lake circulation. Although some transport of water occurred in the offshore direction in the spring when the thermal bar migrated offshore, the major direction of flow was parallel to shore (Ayers et al. 1967). This direction of flow prevented the mixing of inshore, midshore, and offshore assemblages of zooplankton. Areas which were subject to intense fish predation did not have their reduced zooplankton stocks replenished by an influx of water from the zooplankton-rich midshore and offshore areas.

Stations NDC 4-1 and NDC 7-1 did not belong to the inshore group but to the midshore and offshore groups. The reasons for this are not known. Temperature data indicated that water temperatures at these stations were similar to those along the rest of the inshore area. A possible explanation may be that for some unknown reason fish did not migrate inshore in that region of the lake, and so the zooplankton in that area were not subjected to the same intense predation as the zooplankton along the rest of the shoreline experienced. Unfortunately, fish collections were not made in that portion of the lake, so whether or not this is a valid explanation cannot be determined.

ANALYSIS OF THE JULY SURVEY DATA

Results

Figure 29 shows the scatter diagram produced as part of the computer printout of the principal component analysis of the July survey data. The first principal component accounted for 44.1% of the total variance while the second accounted for an additional 24.7% of the variance.

The stations clustered into four groups. The inshore zone consisted of two regions (inshore region A and inshore region B) and extended out to the 5-10 m depth contour (Fig. 30). The midshore zone extended from the inshore zones out to the 15-20 m depth contours while the offshore zone extended beyond the midshore zone and at least out to the 40 m depth contour.

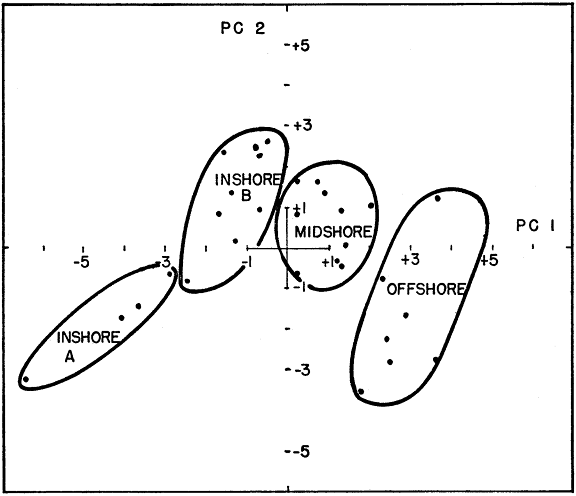


FIG. 29. Plot of the stations against the first and second principal components showing the four zones produced by the principal component analysis of the 11 July 1974 survey data.

The mean abundance, standard deviation, and percentage composition of the 13 taxa used in the analysis are shown in Table 4 for each of the four zones. Table 4 also shows the mean abundance and standard deviation for total zooplankton in each zone.

Inshore zone A had the lowest standing stock of zooplankton (6,675/m^3); the dominant taxa were *Bosmina longirostris* and the immature copepodites of *Cyclops* spp. and *Diaptomus* spp. Zooplankton abundances increased sharply in inshore region B (22,786/m^3). *Bosmina longirostris* were

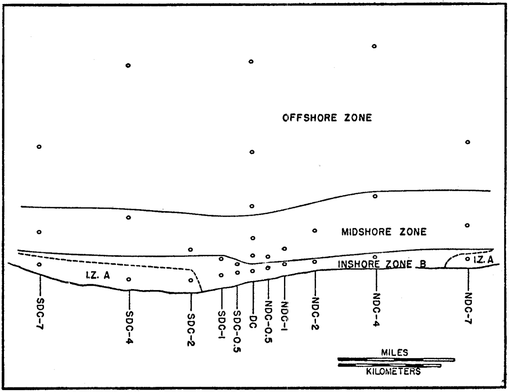


FIG. 30. The three major zones determined from the results of the principal component analysis of the 11 July 1974 survey cruise data.

approximately twice as abundant in inshore region B and continued to dominate the zooplankton. Immature *Cyclops* spp. and *Diaptomus* spp. copepodites were 4-7 times as abundant while adults were 10-17 times more abundant than in inshore region A.

Zooplankton were approximately twice as abundant (44,585/m^3) in the midshore region as in inshore region B. *Bosmina longirostris* and immature *Cyclops* and *Diaptomus* spp. copepodites increased approximately twofold in abundance from inshore region B and were the dominant taxa.

Zooplankton were approximately twice as abundant (80,345/m^3) offshore as in the midshore region and 12 times more abundant than in inshore region A. *Bosmina longirostris*, immature *Cyclops* spp. and *Diaptomus* spp., and adult *Cyclops* spp. were more abundant than in the midshore region and continued to dominate the plankton; adult *Diaptomus* spp.

TABLE 4. Results of the principal component analysis of 11 July 1974 survey data showing the mean abundances, standard deviations of the mean, and the percentage composition of zooplankton in the four zones. "Total zooplankton" refers to the abundance of all the zooplankton including those not used in the analysis. "n" refers to the number of stations in each zone.

Taxa	Inshore A n=4			Inshore B n=9			Midshore n=10			Offshore n=7		
	$\bar{x}$	s	%	$\bar{x}$	s	%	$\bar{x}$	s	%	$\bar{x}$	s	%
Copepod nauplii	221	135	4.8	2010	574	9.4	1887	1043	4.3	984	1122	1.3
Cyclops C1-C5	762	522	13.4	6781	3361	29.1	11556	3710	26.5	19564	6718	26.3
Cyclops C6	102	84	1.5	1482	1355	6.5	3324	1888	7.5	6169	1926	7.7
Diaptomus C1-C5	412	165	9.6	2179	654	10.0	4941	2268	11.1	7675	4163	10.3
Diaptomus C6	150	93	2.9	1726	998	6.9	3453	1316	8.3	3357	2499	4.4
Eurytemora C1-C6	211	18	7.0	401	232	1.8	263	163	0.6	105	89	0.1
Limnocalanus C1-C6	0	-	0.0	0	-	0.0	0	-	0.0	53	59	0.1
Bosmina	4648	5333	57.0	7938	4590	35.0	18830	9233	40.8	41845	34213	48.3
Chydorus	2	3	0.0	20	36	0.1	1	4	0.0	0	-	0.0
Daphnia	4	2	0.1	2	3	0.0	73	70	0.2	390	175	0.5
Eubosmina	2	4	0.0	1	2	0.0	15	18	0.0	41	61	0.1
Polyphemus	25	10	0.8	17	14	0.1	19	18	0.0	43	36	0.1
Asplanchna	230	314	2.3	181	53	0.9	187	141	0.4	15	31	0.0
Total zooplankton	6675	6390	-	22786	8311	-	44585	12335	-	80345	42506	-

appeared in similar numbers in the midshore and offshore regions, Nine of the 13 taxa examined had their maximum abundances in the offshore region; the remaining four were most abundant in the inshore regions.

Discussion

There were several similarities between the results of the April and July analyses. Three major regions (inshore, midshore, and offshore) ran parallel to shore and extended roughly out to the same depth contours. In both months, zooplankton were least abundant inshore and most abundant offshore. Most taxa increased in abundance with distance offshore in July as in April; this increase was greatest for adult *Cyclops* spp. and *Diaptomus* spp.

While the three major regions occurred in the same areas of the survey grid, the physical features within each zone were different in the two months. In April the water was cold, with the warmest water lying inshore. The July cruise was taken during an upwelling (Section 1) and the warmest water was offshore. In April the water was isothermal at every station, while in July the water was thermally stratified.

The upwelling modified the distribution of zooplankton in the inshore zone. One region, inshore zone A, lay on either side of the coldest (<15°C) upwelled water; inshore region B lay in the center of the upwelling. The abundance and species composition of zooplankton in inshore region B was more similar to that in the midshore region than in inshore region A.

As in April, the major direction of water transport in the summer was parallel to shore (Ayers et al. 1967). Therefore differences in zooplankton abundance and species composition between the three major zones tended to be maintained; the upwelling modified this pattern locally.

In April, the water temperatures at each station varied by less than 1°C from surface to bottom. In July, water temperatures varied by as little as 4°C at DC-1 to as much as 15°C at DC-6. It has been shown many times in the literature that zooplankton are not uniformly distributed in the water column (Raymont 1967; Wells 1960) but orient themselves at particular depths in response to temperature, light, and pressure cues

(Moore and Corwin 1956).

In the Cook survey area, integrated vertical net hauls are collected at each station. In the summer, and in the offshore region in particular, zooplankton are collected from a wide thermal regime. However, data collected by Stewart (1974) in August 1973 indicated that at DC-6, the most abundant zooplankton taxa (nauplii, immature *Cyclops* spp., immature *Diaptomus* spp., *C. bicuspidatus*, *D. ashlandi*, *D. oregonensis*, *Tropocyclops prasinus mexicanus*, *Daphnia retrocurva*, and *Bosmina longirostris*) were found throughout the water column. Some forms such as the littoral *Eurytemora affinis* and the cladocerans *Daphnia galeata mendotae* were restricted to the upper 10 or 20 m of the water while the cold water stenotherms *D. sicilis* and *Limnocalanus macrurus* were restricted to the hypolimnion.

The inshore-midshore-offshore differences in zooplankton standing stock were probably not due to the direct effects of the differences in the depth and the thermal regime at each station for most of the taxa of zooplankton examined for the analysis. Although the hypolimnion formed a larger portion of the water column with increasing distance offshore (Section 1), the major species of zooplankton in July inhabit the epilimnion and the hypolimnion at least down to depths of 40 m. These zooplankton probably become rarer only at depths greater than 50 m (Patalas 1969). An integrated vertical net haul collected from 200 m to the surface would have fewer zooplankton/m^3 than a similar one collected from 20 m to the surface, in part because the hypolimnion with its lower standing stock of zooplankton formed a larger fraction of the water column at the deeper station. However, comparisons between stations of depths less than 40 m are probably valid. If inshore-midshore-offshore differences in zooplankton abundance were due to some depth effect, then the offshore region should have had the lowest concentration of zooplankton. This was not observed, and some factor other than depth or thermal regime must have been responsible for the inshore-midshore-offshore differences in zooplankton abundance and species composition.

Variations in abundance and species composition of zooplankton over the survey area did not appear to be associated with variations in abundance

and species composition of phytoplankton. This was in part due to the fact that an upwelling occurred during the cruise. While phytoplankton stocks may increase dramatically in a matter of days in response to nutrient enrichment by upwelling, zooplankton require several weeks or months to respond to an increase in phytoplankton standing stock.

While there were no phytoplankton data collected a few days prior to the upwelling, standing stocks were probably lowest offshore. Phytoplankton have been shown to be more abundant within a mile of shore than further offshore during the summer months for several years of preoperational surveys (Ayers 1975). The sparcity of zooplankton in the inshore area therefore would not appear to have been a function of food limitation.

The percentage of ovigerous *Bosmina longirostris* females was determined at each station; reliable data were not obtained for the other taxa because of their low concentration in the subsamples and the apparently low percentage of ovigerous females. There was a wide range of values (4-28%) with approximately 8.5% of the inshore zone A *Bosmina longirostris* females, 13.4% of the inshore zone B females, 11.7% of the midshore zone females, and 6.1% of the offshore zone females being ovigerous. The offshore region had the highest standing stock of *B. longirostris* and yet the lowest percentage of ovigerous females. Inshore region A was apparently favorable for *B. longirostris* growth and reproduction as the percentage of ovigerous females was equal to or somewhat higher than females in the offshore region. Some factor must therefore have contributed to a high mortality rate of this cladoceran.

In the summer, the inshore area is a nursery ground for the major species of fish. Larvae, young-of-the-year, and adult alewife, spottail shiners, yellow perch, and trout perch are concentrated inshore during the summer months (Wells 1968); in July 1973 these fish accounted for 78%, 10%, 4%, and 4% respectively of the fish collected in the survey area (Jude et al. 1975).

Larval alewife feed mainly upon *Cyclops* spp., *Diaptomus* spp., and *Bosmina* spp. (Norden 1968); in addition, adults consume *Limnocalanus macrurus* and *Epischura lacustris* (Morsell and Norden 1968; Webb and

McComish 1974). Spottail shiners are planktivorous throughout most of their lives; trout perch are primarily benthic feeders but do consume *Cyclops bicuspidatus* (Scott and Crossman 1973). While juvenile and adult yellow perch feed upon cladocerans and possibly copepods (Galbraith 1967), the importance of zooplankton in their diet decreases as it increases in size (Scott and Crossman 1973).

The concentration of large numbers of alewife, spottail shiners, trout perch, and yellow perch in the inshore area may have been the major factor responsible for the low standing stock of zooplankton. As stated above, these fish are planktivores and selectively consume the largest components of the zooplankton. In July, the largest zooplankton were least abundant in inshore region A and showed the most dramatic increases in abundance with distance offshore. *Daphnia* spp. increased nearly 100-fold while adult *Diaptomus* spp. and *Cyclops* spp. increased 18-64 fold in abundance with increasing distance offshore. *Limnocalanus macrurus*, a large calanoid copepod, was absent in the upwelled water in inshore region B but occurred in concentrations of $53/m^3$ in the offshore zone. The smaller immature copepodites of *Diaptomus* spp. and *Cyclops* spp. increased only 14-18 fold in abundance with distance offshore. Smaller taxa such as nauplii, *Bosmina longirostris*, *Polyphemus pediculus*, and *Asplanchna* spp. increased less dramatically with distance offshore. Circumstantial evidence suggests that in July, as in April, the inshore region was an area of intensive fish predation on the zooplankton and that the zooplankton abundance and species composition were significantly altered by this predation.

Although some adult alewife and smelt were found in the midshore and offshore regions in July (Wells 1968; Jude et al. 1975), their concentration was less in these regions than was the concentration of juvenile alewife, spottail shiners, yellow perch, and trout perch in the inshore area. Therefore, the fish predation was probably less offshore than in the inshore area.

ANALYSIS OF THE OCTOBER SURVEY DATA

Results

Figure 31 shows the scatter diagram produced as part of the analysis of the October data. The regions were poorly defined; the first principal component accounted for only 26.7% of the variance while the second accounted for only a further 17.4%.

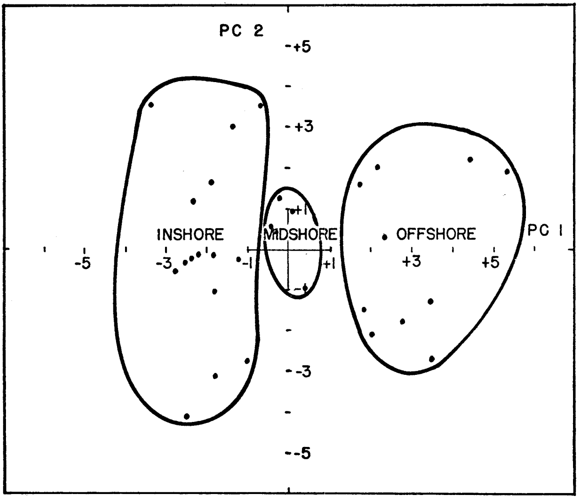


FIG. 31. Plot of stations against the first and second principal components showing the three zones produced by the principal component analysis of the 9 October 1974 survey data.

The inshore stations clustered into three groups (Fig. 32) bounded by the 5-15 m depth contours. The midshore zone lay outside the inshore zone and was bounded by the 10-15 m depth contours; it was located north but not south of the plant site. The offshore zone extended beyond the 15 m depth contour at least as far as the 40 m depth contour.

The mean abundance, standard deviation, and percent composition of the 21 taxa used in the analysis are shown in Table 5 for each of the three zones. Table 5 also shows the mean abundances and standard deviation for the total zooplankton in each zone.

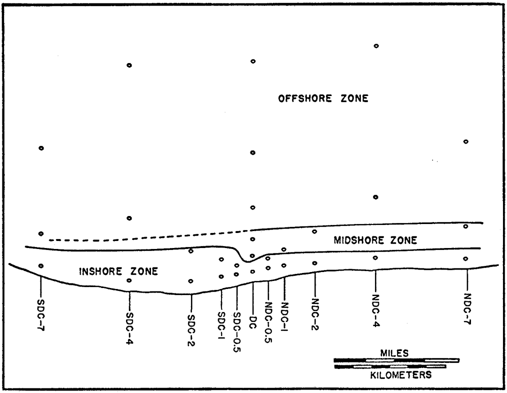


FIG. 32. The three major zones determined from the results of the principal component analysis of the 9 October 1974 survey cruise data.

TABLE 5. Results of the principal component analysis of 9 October 1974 survey data showing the mean abundances, standard deviations of the mean, and percentage composition of the zooplankton in the three zones. "Total zooplankton refers to the abundance of all the zooplankton including those not used in the analysis. "n" refers to the number of stations in each zone.

Taxon	Inshore n=15			Midshore n=5			Offshore n=10		
	$\bar{x}$	s	%	$\bar{x}$	s	%	$\bar{x}$	s	%
Copepod nauplii	921	381	6.2	796	197	4.1	660	222	2.7
Cyclops C1-C5	2842	801	19.1	4494	444	22.9	6785	2137	28.2
Cyclops C6	587	306	3.7	678	182	3.5	1168	438	4.8
Tropocyclops C1-C6	1183	511	7.8	1247	258	6.4	973	305	4.2
Mesocyclops C1-C6	0	-	0.0	1	3	0.0	3	4	0.0
Diaptomus C1-C5	1905	802	12.8	5537	1420	28.2	9303	2785	39.1
Diaptomus C6	219	128	1.4	279	64	1.4	482	203	2.0
Epischura C1-C6	369	257	2.5	337	174	1.7	642	518	2.5
Eurytemora C1-C6	104	64	0.7	94	64	0.5	46	43	0.2
Limnocalanus C1-C6	0	-	0.0	0	-	0.0	26	66	0.1
Canthocamptus C1-C6	4	6	0.0	0	-	0.0	0	-	0.0
Bosmina	177	130	1.1	123	58	0.6	398	203	1.6
Ceriodaphnia	1	2	0.0	1	2	0.0	3	8	0.1
Chydorus	10	10	0.1	18	17	0.1	28	22	0.1
Daphnia	4456	1924	28.4	4398	1522	22.3	2495	1152	10.2
Diaphanasoma	14	21	0.1	19	17	0.1	19	18	0.1
Eubosmina	2300	996	15.3	1499	210	7.6	818	340	3.4
Holopedium	12	9	0.1	28	23	0.1	49	29	0.2
Leptodora	81	37	0.5	68	41	0.3	56	32	0.2
Polyphemus	0	2	0.0	0	-	0.0	3	10	0.0
Alona	0	-	0.0	0	-	0.0	1	3	0.0
Asplanchna	6	5	0.0	6	4	0.0	44	45	0.2
Total zooplankton	15189	4698	-	19623	1320	-	24001	6475	-

The inshore zone had the lowest standing stock of zooplankton ($15,189/m^3$). The cladocerans *Daphnia* spp. and *Eubosmina coregoni* and the immature copepodite stages of *Cyclops* spp. and *Diaptomus* spp. were the dominant taxa. The midshore zone had a zooplankton standing stock of $19,623/m^3$, which was only slightly larger than that of the inshore zone. The dominant taxa were *Daphnia* spp. and immature *Cyclops* spp. and *Diaptomus* spp. copepodites. The offshore region had a zooplankton standing stock ($24,001/m^3$) 1.6 times greater than the inshore region. The dominant taxa were *Daphnia* spp., and immature *Cyclops* spp. and *Diaptomus* spp. copepodites.

Discussion

As in April and July, the survey area was divisible into three major zones--an inshore, a midshore, and an offshore zone. However, while the zones extended roughly out to the same depth contours, the distinction between zones was smaller in October than in April or July.

October was a period of uniform temperatures over the survey area. Surface water temperatures varied by less than 1°C from station to station. The upper 20 m of the water column varied by less than 2°C and it was only at stations further than 10 km from shore that the thermocline was evident (Section 1). While the direction of water flow was largely parallel to shore (Ayers et al. 1967), some exchange of water in the offshore direction occurred as intense cooling took place in the inshore region.

Secchi disc depths varied by less than 2 m over the survey area with the minimum depth (<2 m) occurring within 1 km of shore (Section 1). Phytoplankton cell counts varied from 1,300 to 2,300/ml over the short survey grid. Flagellates occurred in similar numbers (200-400/ml) over the survey grid. Diatoms were slightly more abundant in the inshore area (500-800/ml) than the offshore area (200-450/ml) while coccoid blue-greens were more abundant offshore (900/ml) than inshore (350-650/ml) (Ayers 1975).

October was a period of fish migration from their summer nursery grounds to their overwintering grounds in the deeper portions of the

lake. The dominant fish collected in October 1973 (1974 data not currently available) was the alewife, which accounted for 92% by numbers of fish. Large numbers of young-of-the-year were found in the beach zone and further offshore while adults were located only offshore (Jude et al. 1975). Spottail shiners, trout perch, yellow perch, and smelt are generally found only in the deeper offshore waters in the autumn (Wells 1968). These fish were rarely captured in October 1973 and, apart from the spottail shiner which accounted for 4% of the fish catch, accounted for less than 1% of the fish.

Intensive predation by planktivorous fish was suggested as being the major factor responsible for the low standing stock of zooplankton in the inshore area in April and July. This selective fish predation on the largest zooplankton probably also occurred in October with larval alewife being the most significant consumer. However, predation on the zooplankton by planktivorous fish was dispersed over a wider area in October than in April or July.

The dispersal in the distribution of planktivorous fish apparently resulted in zooplankton being more uniformly distributed over the survey area in October than in April and July. The total standing stock of zooplankton varied only slightly from the inshore region to the offshore region. Large zooplankton such as adult *Cyclops* spp. and *Diaptomus* spp. varied less than 2-fold in abundance over the three regions. *Limnocalanus macrurus* varied more markedly in abundance but was probably restricted from the inshore area by its intolerance for the warmer water (14°C). *Epischura lacustris* and *Daphnia* spp. also varied only 2-fold over the survey area. This again contrasts with July when the variation in the abundance of the larger zooplankton from the inshore area to the offshore area was considerably larger. As in July, many of the smaller zooplankton (*Bosmina longirostris, Polyphemus pediculus, Tropocyclops prasinus mexicanus,* and nauplii) varied less in abundance with distance offshore.

In the autumn with the more uniform physical (temperature) and biological (phytoplankton standing stock, distribution of planktivorous fish) conditions over the survey area, competition for similar resources

may become more important in regulating the abundance and species composition of the zooplankton taxa in a region. Nauplii, *Bosmina longirostris*, *Daphnia* spp., and *Eubosmina coregoni* are all herbivores and may compete for similar resources. *Cyclops bicuspidatus* (McQueen 1969) and *Epischura lacustris* (Main 1962) are omnivores and feed upon nauplii and immature copepodites. *Leptodora kindtii* is a carnivorous cladoceran which feeds upon *Diaptomus* spp., *Cyclops* spp., *Daphnia* spp., and possibly other taxa of zooplankton (Sebestyen 1931). The rotifer *Asplanchna* spp. feed upon rotifer species which may compete with the herbivorous cladocerans (Edmondson 1960).

GENERAL DISCUSSION AND SUMMARY

Initial analyses of the April, July and October major survey cruise data for 1974 have shown that the survey area could be divided into three major regions. These regions ran parallel to shore and were described as an inshore, a midshore, and an offshore region.

The inshore region extended roughly out to the 5-10 m depth contours; it was characterized by a low standing stock of zooplankton and by the dominance of the smaller components (nauplii, immature *Cyclops* spp. and *Diaptomus* spp. copepodites, *Bosmina longirostris*) of the zooplankton. The midshore region extended beyond the inshore region out to the 15-20 m depth contours; it was characterized by a larger standing stock of zooplankton than the inshore region and by the increasing dominance of the larger taxa of zooplankton. The offshore region extended beyond the midshore region and at least as far as the 40-m depth contour; it was characterized by the greatest standing stock of zooplankton and by the dominance of the largest taxa (adult *Cyclops* spp. and *Diaptomus* spp., and *Limnocalanus macrurus* copepodites).

There is strong circumstantial evidence which suggests that intense size-selective fish predation was the most important factor for the low standing stock of zooplankton in the inshore area, particularly in April and July. The numerically dominant fish in the survey area were the alewife, smelt, spottail shiner, yellow perch, and trout perch which used

the inshore area as a breeding and nursery ground during the spring and summer. These fish are planktivores; many have been shown to have exerted such a significant grazing pressure on the zooplankton that they have altered the species composition of zooplankton in various bodies of water over a number of years. The survey data presented in this section suggest that these fish can also cause spatial heterogeneities in the distribution of zooplankton.

While field data taken in conjunction with many studies reported in the literature suggest that selective fish predation was the major factor responsible for the inshore-offshore differences in zooplankton abundance and species composition, this is difficult to prove because: 1) Apart from the fish larvae, most of the fish data for the survey are expressed in units of number of fish collected rather than number of fish per volume of water. This makes it difficult to estimate the population size of many of the fish in the survey area. 2) It is difficult to determine from the literature how many zooplankton of a particular taxa a species of fish consumes during a day. Stomach content data are expressed in percentage composition units rather than in concentration units. Various taxa of zooplankton are more readily digested than others and the examination of the stomach contents of a fish may not always give a good estimate of the species of zooplankton consumed, particularly if the fish has not fed for some time.

In order to prove that zooplankton are consumed by the fish in the inshore area at a faster rate than they are replaced (through reproduction), it will be necessary to overcome these problems in some manner. Then a dynamic description of zooplankton birth and death rates and fish predation rates would have to be made. Such a study may be conducted at a later time in order to better describe the interactions between fish and zooplankton in the inshore area.

Preliminary analysis of phytoplankton data failed to show that zooplankton were more abundant or had a certain species composition in an area due to the phytoplankton standing stock of species composition. Phytoplankton were most abundant inshore while zooplankton were least

abundant in this region. Zooplankton grazing pressure on the phytoplankton was probably greatest offshore; this pressure was probably a significant factor in contributing to the lower standing stock of phytoplankton in the offshore region.

There was no indication from any of the analyses that water from the St. Joseph River, Michigan City or Gary, Indiana, or from the towns and streams along the shore of the survey area affected the spatial distribution of zooplankton. Nor was there any evidence of the Michigan city-Benton Harbor eddy in the survey area. However, the pattern of water circulation was important in maintaining the definition between zones or, in July, producing a fourth zone.

Depth *per se* was probably not an important factor in the formation of zones. Littoral forms such as *Eurytemora affinis* decreased in abundance with distance offshore at some times of the year although they were frequently most abundant some distance from shore where fish predation was less intense. Deep-water forms such as *Limnocalanus macrurus* and *Diaptomus sicilis* were restricted offshore by their intolerance to the higher epilimnetic temperatures. Their absence in the inshore region during July when an upwelling had occurred may have been due to selective fish predation.

Differences in competitive success among various zooplankton taxa may contribute to the formation of zones although this was not investigated. These factors may have been of particular importance in the autumn when the planktivorous fish were dispersed over a wider area and when temperature and phytoplankton distributions were similar over the entire area.

SECTION 4

INVESTIGATION OF HETEROGENEITIES IN ZOOPLANKTON ABUNDANCE AND SPECIES COMPOSITION IN THE FOREBAY

INTRODUCTION

In 1974 when the circulating pumps became operational, the zooplankton investigations were expanded to include 1) determinations of numbers and species compositions of zooplankton which are subject to condenser passage, and 2) determinations of numbers and species composition of zooplankton which are killed by condenser passage.

Samples for these mortality determinations must be collected from the water entering the plant from the forebay and from the water leaving the plant from the discharge bay. According to technical specifications for this study, samples for zooplankton abundances and species composition determinations must also be collected from the forebay and discharge bay areas.

The design of the forebay is such that it is possible to collect zooplankton from many locations along the forebay and from many depths. Therefore it was necessary to determine a statistically representative sampling location and depth in the forebay. This section presents the results of these investigations.

The design of the discharge bay is such that it is possible to sample from only one location in the discharge bay area. The velocity of the water in the discharge bay area is so high that it was necessary to introduce a rigid pipe apparatus which could be used to sample from this turbulent area. Samples can be collected from only one depth in the discharge bay.

8 MAY 1974 STUDY

Introduction

Cooling water is drawn from Lake Michigan through three 4.9 m diameter pipes located 686 m offshore in 7.3 m of water. The intake cribs form an equilateral triangle whose sides are approximately 76 m long and whose base is parallel with the shore (U.S. Atomic Energy Commission 1973).

Lake water passes from the three intake pipes into the forebay (see Fig. 1) which forms the "basement" of the screenhouse, an area approximately 50 m long, 27 m wide, and 12 m deep. Although the forebay is 12 m deep, the actual height of the water varies with the level of the lake; in 1974 there were 9 m of water.

Access to water in the forebay is through a series of grates less than 1 m wide running along the western side of the screenhouse. Therefore samples for zooplankton abundance determinations can be collected anywhere along the 50-m length of the screenhouse and anywhere within the 9 m of water.

It was expected that water within the forebay would have a homogeneous distribution of zooplankton. As the mouths of the three intake pipes are located within 75 m of each other, the pipes should sample similar water masses. Water is drawn through the intake pipes at 183 cm/sec and enters the forebay at this velocity. The water passes through the travelling screens in the forebay at 39.6 cm/sec (U.S. Atomic Energy Commission 1973). These velocities are high, and water from the three intake pipes should be well mixed in the forebay. The velocity of the water in the forebay is higher than the swimming velocity of Lake Michigan zooplankton. As the lake water passes through the forebay in a matter of seconds zooplankton should not have time to migrate to particular depths or regions; therefore there should be homogeneous distributions of zooplankton throughout this area.

The discharge bay on the north side of the screenhouse receives the water from the condensers of Unit 1 and has a 4.9-m diameter discharge pipe. In 1974, construction was completed only on Unit 1 so that all the water drawn into the forebay circulating pumps of Unit 1 was passed through the north discharge bay of Unit 1.

Zooplankton samples can be collected at only one location within the discharge bay of Unit 1. However, because the water within this area is a mixture of water from the three intake pipes and because of the high velocity of this water, it would seem unlikely that spatial heterogeneities in the distribution of zooplankton could arise.

If the water is as well mixed in the forebay as in the discharge bay, a sample of water collected from the forebay would have the same species abundances and compositions as a sample collected from the discharge bay. Similarly, samples collected from two locations within the forebay would have the same abundances and species compositions of zooplankton.

Results of preliminary studies conducted by Stewart (1974) indicated that there were statistically significant differences in the mean abundances of zooplankton collected at different grates within the forebay ($p<.01$ for total zooplankton, *Cyclops* and *Diaptomus*) and possibly from different depths ($p<.05$ for nauplii and harpacticoid copepods). Following up these preliminary studies, further tests were initiated to resolve whether or not there was spatial heterogeneity in the distribution of zooplankton in the forebay in May 1974. This study focussed on the spatial and temporal variations in zooplankton abundance and species composition in the forebay.

Materials and Methods

The collection apparatus consisted of a diaphragm pump which drew water up through a 7.6-cm diameter plastic hose. The water passed from the pump through a 20-cm diameter net (158μ mesh) which was suspended in a barrel of water in order to minimize the damage inflicted on the zooplankton. Water flowed out the bottom of the barrel through an outlet pipe equipped with a flowmeter which allowed estimates to be made of the pumping rate of the diaphragm pump.

The diaphragm pump drew approximately 50 gallons of water per minute. At this pumping rate, water passed through the intake hose at 75.5 cm/sec. It is unlikely that the escape velocity of any of the zooplankton within the forebay was great enough to enable them to avoid being drawn into the hose. Also, as the velocity of the water in the forebay was approximately 39.6 cm/sec, zooplankton would not have been able to detect any vortices near the mouth of the hose or to react fast enough to escape capture.

The sampling program was designed to investigate whether there were significant differences in abundances of zooplankton at different grates, different depths, over periods of time of less than 5 hr, and between day and night. Samples were collected from midnight to 0500 and from noon to 1700 on 8 May. The sampling period was long because only one diaphragm pump was available, which necessitated a great deal of time in moving the hose and pump.

Two sample locations were chosen on the Unit 1 side of the screenhouse, one in front of travelling screen MTR 1-1 north of the screenhouse and the second approximately 21 m south in front of travelling screen MTR 1-5. In this report, the locations will be referred to as grates MTR 1-1 and MTR 1-5. This method replaces previous methods of numbering the grates either by assigning numbers to individual grates or to sections of grates.

Samples were collected 0.6, 5.5, and 8.5 m below the surface of the water. At midnight two 2-min samples were collected at each grate and at each depth and then the series were repeated. This procedure was followed during the noon series. A total of 48 samples were collected, which were later counted for zooplankton species composition and abundances by using the procedure outlined in Stewart (1974).

Data were examined by using an analysis of variance for factorial design performed on the Michigan Terminal System and employing California Biomedical Series program number BMD02V. Abundance data were first transformed to logarithms ($y = \log (x + 1)$). The percentage composition data were converted to the inverse-sine square root transformation (Steel and Torrie 1960). Four variables were analyzed, grates (2) x depths (3) x time (2) x day-night (2).

Data were further analyzed in order to determine whether particular species were heterogeneously distributed in the forebay. Zooplankton of a variety of shapes, sizes, and swimming ability were selected for further analysis.

Nauplii are generally the smallest components of the zooplankton retained with a #10 mesh (158μ) net; they are spherical in shape. Nauplii

are weak swimmers although they are capable of rapid darting movements over short distances. The cladoceran *Bosmina longirostris* is spherical and somewhat larger (0.2-0.5 mm). These organisms are weak swimmers; when disturbed they may close their carapace.

Copepods are rectangular in shape. *Diaptomus* spp., *Cyclops* spp., and *Eurytemora affinis* are approximately 1 mm in size as adults; the earliest or first copepodite stage in approximately the same size as nauplii. Copepods are capable of rapid, darting movements; because of their larger size and more streamlined shape they can dart further per movement than nauplii.

Species abundance data were transformed to the logarithm ($y = \log (x + 1)$) before the analysis. The species percent composition data were analyzed after transformation to the arcsine-square-root (Steel and Torrie 1960).

Results

Figure 33 shows the mean density of zooplankton collected at the two grates, three depths, two sampling times, and during the day and night; results of the analysis of variance are presented in Table 6. There was a significant ($p<.005$) difference in the abundance of zooplankton at grates MTR 1-1 and MTR 1-5. Grate MTR 1-5 had approximately 25% more zooplankton than grate MTR 1-1. There was also a significant ($p<.005$) grate x day-night interaction; the two grates had similar densities of zooplankton during the day while grate MTR 1-5 had approximately 60% more animals per cubic meter during the night than grate MTR 1-1. There was a statistically significant ($p<.05$) grate x depth interaction; zooplankton densities increased with depth at grate MTR 1-1 whereas at grate MTR 1-5 densities were minimal at 5.5 m and maximal at 8.5 m.

While the abundance of total zooplankton was similar in the forebay during the day and night, the abundance of several taxa of zooplankton varied significantly (Table 7) over the two periods. Nauplii and *Diaptomus* spp. copepodites (Fig. 34a,d,g) were more abundant during

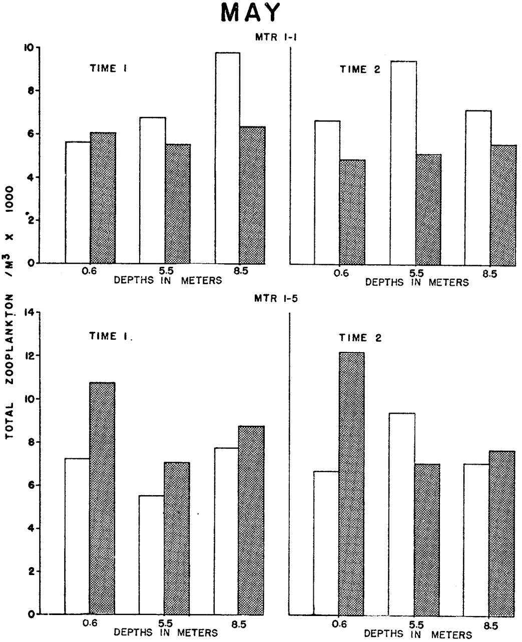


FIG. 33. Concentration of zooplankton collected in the fore-bay at 2 grates, 2 sampling times over a period of 6 hr, 3 depths, and during the day and night on 8 May 1974. Each histogram is the mean of 2 replicates.

TABLE 6. Results of the factorial analysis of variance on the log-transformed data for abundances of total zooplankton found in the 8 May 1974 heterogeneity study of the intake forebay. A value of n.s. indicates that the effect was not significant at the 95% level.

Source of variation	Degrees of freedom	Mean squares	Attained level of significance
Day-night (1)	1	0.0083	n.s.
Grate (2)	1	0.1210	.005
Time (3)	1	0.0027	n.s.
Depth (4)	2	0.0031	n.s.
1 x 2	1	0.1114	.005
1 x 3	1	0.0235	n.s.
1 x 4	2	0.0271	n.s.
2 x 3	1	0.0183	n.s.
2 x 4	2	0.0318	.05
3 x 4	2	0.0274	n.s.
1 x 2 x 3	1	0.0002	n.s.
1 x 2 x 4	2	0.0013	n.s.
1 x 3 x 4	2	0.0156	n.s.
2 x 3 x 4	2	0.0005	n.s.
1 x 2 x 3 x 4	2	0.0048	n.s.
Within replicates	24	MSE = 0.0088	-

the day while *Cyclops* spp. and *Eurytemora affinis* (Fig. 34b,c,e,f) were more abundant during the night. *Bosmina longirostris* (Fig. 34h) occurred in similar numbers during the day and night. The percentage due to each of the seven taxa varied significantly during the day and night.

The abundance and percentage composition of some taxa varied significantly with time. However, these significance levels were lower than for the day-night variations.

The percentages due to immature *Diaptomus* spp. and *Eurytemora*

TABLE 7. Results of analysis of variance on log-transformed zooplankton abundance data and inverse-sine square root transformed species percentage composition data for the 8 May 1974 day-night x grate x time x depth heterogeneity study in the forebay. "n.s." indicates that an effect was not significant at the 0.95 probability level.

		Significance level - Abundance data							
Source of variance	Degree of freedom	Nauplii	*Cyclops* Imm.	*Cyclops* Adult	*Diaptomus* Imm.	*Diaptomus* Adult	*Eurytemora* Imm.	*Eurytemora* Adult	*Bosmina*
Day-night (1)	1	.0005	.025	.001	.0005	.0005	.0005	.0005	n.s.
Grate (2)	1	n.s.	n.s.	n.s.	.0005	n.s.	n.s.	n.s.	n.s.
Time (3)	1	n.s.	n.s.	n.s.	n.s.	.01	.01	n.s.	n.s.
Depth (4)	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 2	1	.025	.025	.001	.0005	n.s.	n.s.	n.s.	n.s.
1 x 3	1	n.s.	n.s.	.05	n.s.	.025	n.s.	n.s.	n.s.
1 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2 x 3	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2 x 4	2	n.s.	n.s.	.05	n.s.	n.s.	.005	n.s.	.05
3 x 4	2	n.s.	.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 2 x 3	1	n.s.	n.s.	n.s.	n.s.	.025	n.s.	n.s.	n.s.
1 x 2 x 4	2	.025	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 3 x 4	2	n.s.	n.s.	.025	n.s.	n.s.	n.s.	n.s.	n.s.
2 x 3 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 2 x 3 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

		Significance level - Percentage composition data							
Source of variance	Degree of freedom	Nauplii	*Cyclops* Imm.	*Cyclops* Adult	*Diaptomus* Imm.	*Diaptomus* Adult	*Eurytemora* Imm.	*Eurytemora* Adult	*Bosmina*
Day-night (1)	1	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.025
Grate (2)	1	n.s.	n.s.	n.s.	.0005	n.s.	.0005	n.s.	n.s.
Time (3)	1	n.s.	.01	.005	.0005	.025	.0005	n.s.	n.s.
Depth (4)	2	n.s.	n.s.	n.s.	.025	n.s.	n.s.	n.s.	n.s.
1 x 2	1	n.s.	n.s.	n.s.	.0005	n.s.	.0005	n.s.	n.s.
1 x 3	1	.001	n.s.	.005	.005	.025	.005	n.s.	n.s.
1 x 4	2	.01	n.s.	n.s.	.001	.025	n.s.	n.s.	n.s.
2 x 3	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2 x 4	2	.025	n.s.	n.s.	.01	n.s.	.025	n.s.	.05
3 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 2 x 3	1	n.s.	n.s.	.025	.025	.05	n.s.	n.s.	n.s.
1 x 2 x 4	2	.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 3 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2 x 3 x 4	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1 x 2 x 3 x 4	2	n.s.	n.s.	.025	n.s.	n.s.	n.s.	n.s.	n.s.

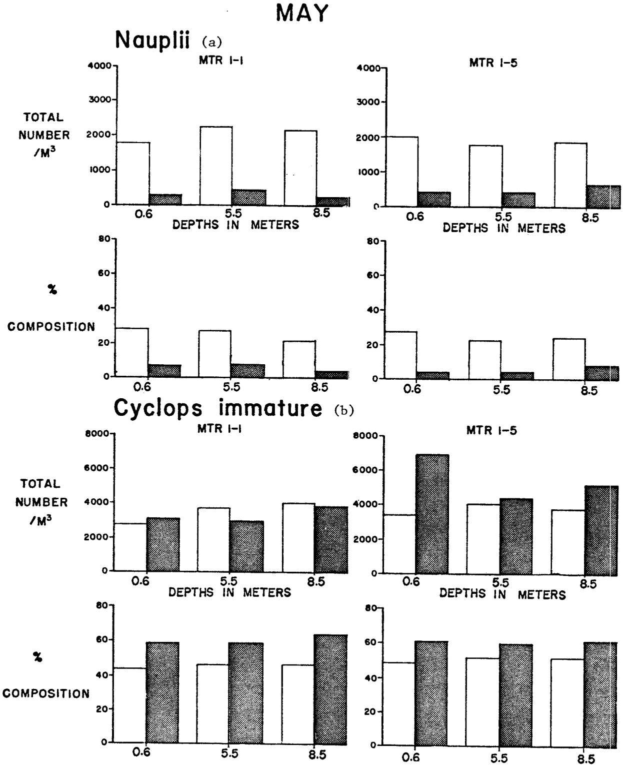


FIG. 34. Concentration and percentage compositions of the various taxa collected from the forebay at 2 grates, 3 depths, and during the day and night on 8 May 1974 (each histogram is the mean of 2 replicates and 2 sampling times). (a) Nauplii; (b) immature *Cyclops* spp.

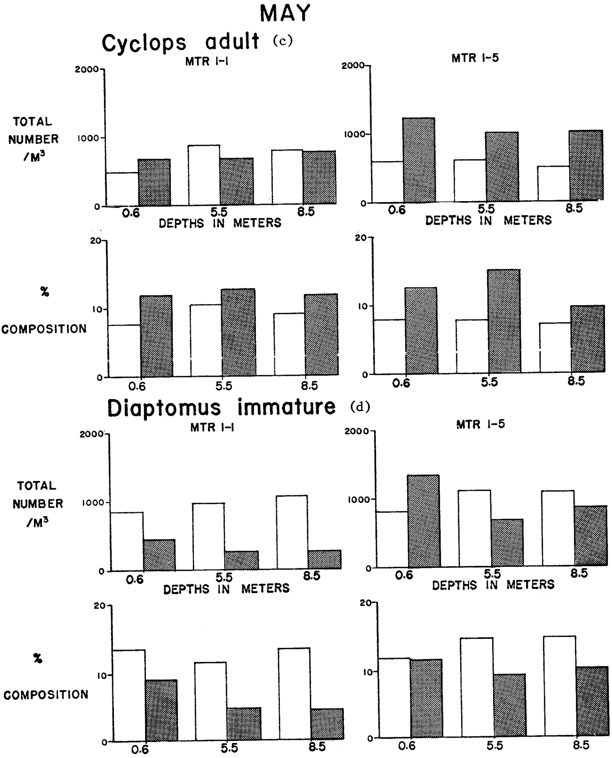


FIG. 34 continued. (c) Adult *Cyclops* spp.; (d) immature *Diaptomus* spp.

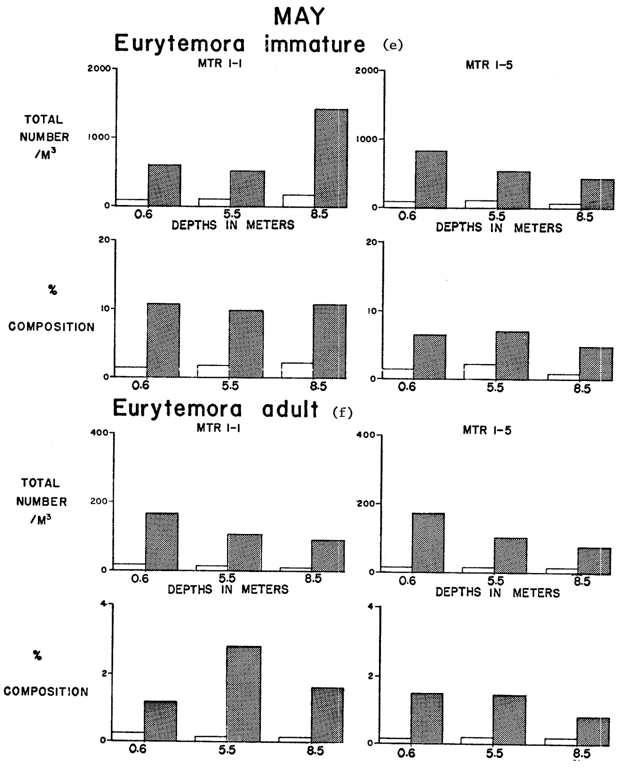


FIG. 34 continued. (e) Immature and (f) adult *Eurytemora affinis*.

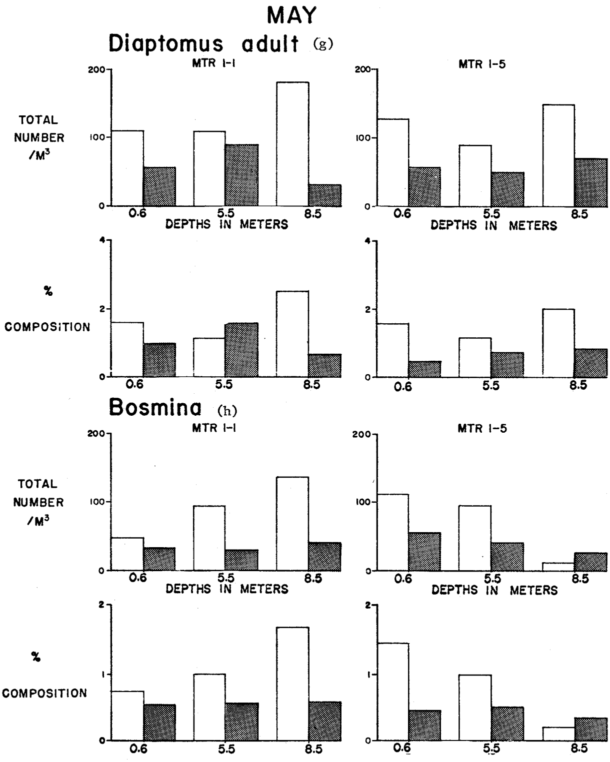


FIG. 34 continued. (g) Adult *Diaptomus* spp.; (h) *Bosmina longirostris.*

affinis copepodites varied significantly between grates.

Nauplii, *Cyclops* spp. copepodites, and immature *Diaptomus* spp. copepodites were all significantly more abundant at grate MTR 1-5 during the night than during the day and than at grate MTR 1-1 during the day and night. These taxa accounted for more than 75% of the total zooplankton, and the differences in abundances of these taxa during the day and night at the two grate locations was probably responsible for the significant day-night x grate interaction for total zooplankton.

The other sources of variation were generally less significant. Abundance and species composition of zooplankton was similar at all three depths. While there were grate x depth interactions, significance levels were lower than for day-night, grate, and day-night x grate significance levels.

Discussion

Results of the May study indicated that there were statistically significant differences in abundance and species composition of zooplankton in the forebay. Some of these differences were anticipated, and allowances were incorporated in the design of the sampling program for 1975 postoperational condenser passage studies.

Many species of zooplankton undergo diel vertical migrations (Wells 1960). Some forms may be at the same depths as the intakes during the day but move closer to the surface at night. Other forms may live on or near the bottom at night and may be in close proximity to the intakes only during the day.

Zooplankton are patchy in distribution. Water masses flowing past the plant site may contain different species compositions and abundances of zooplankton. This would be most obvious on days in which the lake currents were strong or if an upwelling were to occur.

The 1975 postoperational program has been designed to include abundance sampling in the forebay at sunset, midnight, sunrise, and noon over approximately a 24-hr period. These sampling times will compensate for changes in the vertical distribution of zooplankton and for changes

in the water masses flowing past the intakes.

While the results suggest that at any one time zooplankton were heterogeneously distributed in the forebay, particularly with respect to grate, the reasons for these differences were not obvious. They were apparently associated with all categories of zooplankton. Larger and stronger swimming zooplankton were apparently not concentrating at particular depths or at particular locations along the forebay.

The power plant operated different circulating pumps during the collection series. Pump 1-1 ran 12 hr previous to the sampling program, pump 1-2 ran for the following 12 hr during the night series, while pump 1-3 ran for the 12 hr which included the day series. While it is unlikely that differences in power plant pump operation significantly affected the results of the study, this was subject to a test by repeating the sampling program in August.

6 AUGUST 1974 STUDY

Introduction

The study conducted in August was similar to that conducted in May with five modifications: 1) The three circulating pumps of Unit 1 ran for 12 hr prior to study and during the following 24-hr sampling period. This was representative of 1975 postoperational conditions. 2) Three diaphragm pumps were used to collect zooplankton instead of only one. This allowed simultaneous sampling at three locations. 3) A single series was collected at midnight and a single series at noon, rather than the two at each period. 4) Zooplankton were collected at three grates in August rather than at two. An additional grate location was added, as results of the May study indicated there were large differences in zooplankton abundances between grates. 5) The zooplankton species composition was different in August.

Materials and Methods

Methods and analyses were the same as in May except that MTR 1-3 was also sampled. Diaphragm pumps were set up at grates MTR 1-1, MTR 1-3, and MTR 1-5 and replicate 2-min samples were simultaneously

collected at 0.6 m, then at 5.5 m and finally at 8.5 m. Samples were collected from midnight to 0200 and from noon to 1330 on 6 August 1974.

Results

Figure 35 shows the mean densities of total zooplankton collected at the three grates and three depths during the day and night; more ($p<.05$) were collected during the day than at night (Table 8). Zooplankton increased in abundance with depth ($p<.05$) with mean abundances varying from $35,761/m^3$ at 0.5 m to a maximum of $45,400/m^3$ at 8.5 m. They exhibited large differences in mean abundance between grates ($p<.0005$). As in May, zooplankton were more abundant at grate MTR 1-5 ($57,370/m^3$) than at MTR 1-1 ($32,467/m^3$); they were least abundant at MTR 1-3 ($29,492/m^3$).

The abundance and percentage composition of 14 taxa of zooplankton were analyzed. Results are presented in Table 9 and Figure 36. Most species exhibited statistically significant day-night differences in abundance and percentage composition. However, only adult *Cyclops bicuspidatus* and immature *Eurytemora affinis* had significant differences in abundance with depth.

As in May, many taxa had significantly different abundances at the three grates; the only exception was *Cyclops vernalis*. For all taxa of zooplankton, maximum abundances occurred at MTR 1-5 and minimums at MTR 1-3. However, most taxa had similar percentage compositions at all three grates.

There was only one statistically significant interaction (day-night x grate for immature *Eurytemora affinis* abundance data). This contrasts with the May study in which there were several significant day-night x grate, and grate x depth interactions.

Discussion

Results of the August study were essentially the same as those in May. Zooplankton again varied markedly in abundance and species composition over the 14-hr period, and were heterogeneously distributed in the

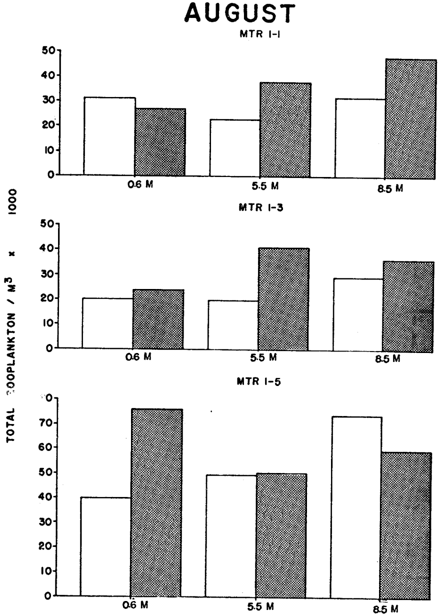


FIG. 35. Concentration of zooplankton collected in the forebay at 3 grates, 3 depths, and during the day and night on 6 August 1974. Each histogram is the mean of the 2 replicates.

TABLE 8. Results of factorial analysis of variance on log transformed abundance data for total zooplankton found in the 6 August 1974 heterogeneity study of the intake forebay. A value of n.s. indicates the effect was not significant at the 95% level.

Source of variation	Degree of freedom	Mean squares	Attained level of significance
Day-night (1)	1	0.0673	.05
Grate (2)	2	0.3501	.0005
Depth (3)	2	0.0570	.05
1 x 2	2	0.0065	n.s.
1 x 3	2	0.0135	n.s.
2 x 3	4	0.0069	n.s.
1 x 2 x 3	4	0.0351	n.s.
Within replicates	18	MSE = 0.0140	

forebay at any one sampling time.

Zooplankton varied in abundance between depths, but these variations were small in comparison to other sources of variation and had low significance levels. Largest variations in abundances in the forebay were associated both in May and August with variations along a horizontal gradient, i.e., with grate location, and were associated with all taxa of zooplankton. Therefore it does not appear to have been a function of some factor operating selectively on zooplankton of a certain size, shape, or swimming ability.

QUEST FOR THE MOST REPRESENTATIVE SAMPLING LOCATION

Analyses of variance performed on May and August data indicated there were statistically significant differences in mean abundance of total zooplankton at the 6 or 9 locations which were examined. Such differences could have been obtained under several conditions. At one

TABLE 9. Results of analysis of variance on log-transformed zooplankton abundance data and inverse-sine square root transformed species composition data for 6 August 1974 day-night x grate x depth heterogeneity study in the forebay. A value of n.s. indicates that an effect was not significant at the 0.95 probability level.

	Source of varisnce (abundance data)						
Taxon	Day-night (1)	Grate (2)	Depth (3)	1 x 2	1 x 3	2 x 3	1 x 2 x 3
Bosmina	.05	.005	n.s.	n.s.	n.s.	n.s.	n.s.
Daphnia	n.s.	.01	n.s.	n.s.	n.s.	n.s.	.05
Holopedium	.0005	.005	n.s.	n.s.	n.s.	n.s.	n.s.
Asplanchna	.005	.005	n.s.	n.s.	n.s.	n.s.	n.s.
Nauplii	n.s.	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
Tropocyclops	n.s.	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
C. bicuspidatus immature	n.s.	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
C. bicuspidatus adult	.001	.001	.025	n.s.	n.s.	n.s.	n.s.
C. vernalis immature	.0005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
C. vernalis adult	.0005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Diaptomus immature	n.s.	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
Diaptomus adult	.025	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
Eurytemora immature	.0005	.0005	.025	.025	n.s.	n.s.	n.s.
Eurytemora adult	.0005	.05	n.s.	n.s.	n.s.	n.s.	n.s.
Degree of freedom	1	2	2	2	2	4	4

	Source of variance (percentage-composition data)						
Taxon	Day-night (1)	Grate (2)	Depth (3)	1 x 2	1 x 3	2 x 3	1 x 2 x 3
Bosmina	.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Daphnia	.001	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Holopedium	.0005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Asplanchna	.005	.005	n.s.	n.s.	n.s.	n.s.	n.s.
Nauplii	n.s.	.0005	n.s.	n.s.	n.s.	n.s.	n.s.
Tropocyclops	n.s.	.0005	n.s.	n.s.	n.s.	n.s	n.s.
C. bicuspidatus immature	n.s.	.005	n.s.	n.s.	.025	n.s.	n.s.
C. bicuspidatus adult	.01	.05	n.s.	n.s.	n.s.	n.s.	n.s.
C. vernalis immature	.001	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
C. vernalis adult	.0005	.025	n.s.	n.s.	n.s.	n.s.	n.s.
Diaptomus immature	.0005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Diaptomus adult	.025	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Eurytemora immsture	n.s.	n.s.	.01	n.s.	n.s.	n.s.	n.s.
Eurytemora adult	.0005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Degree of freedom	1	2	2	2	2	4	4

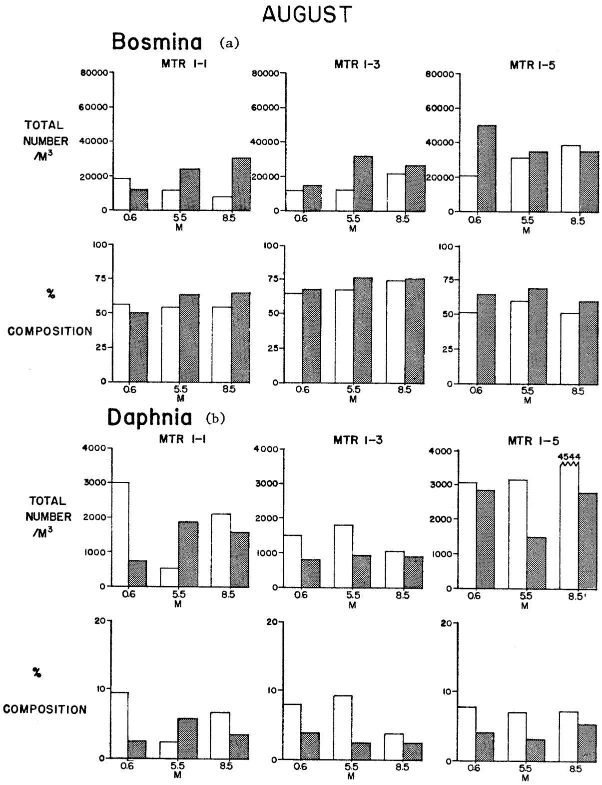


FIG. 36. Concentration and percentage composition of the various taxa collected in the forebay at 3 grates, 3 depths, and during the day and night on 6 August 1974. Each histogram is the mean of 2 replicates. (a) *Bosmina longirostris;* (b) *Daphnia* spp.

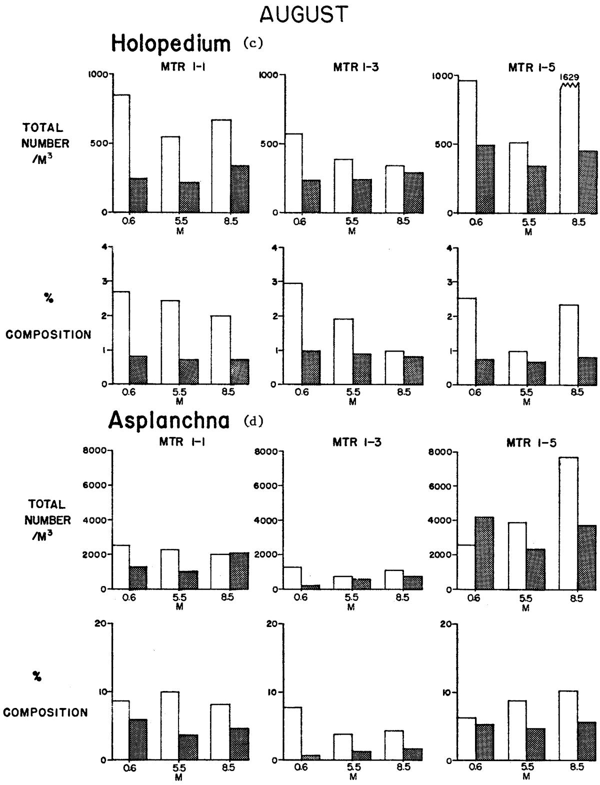


FIG. 36 continued. (c) *Holopedium gibberum;* (d) *Asplanchna priodenta.*

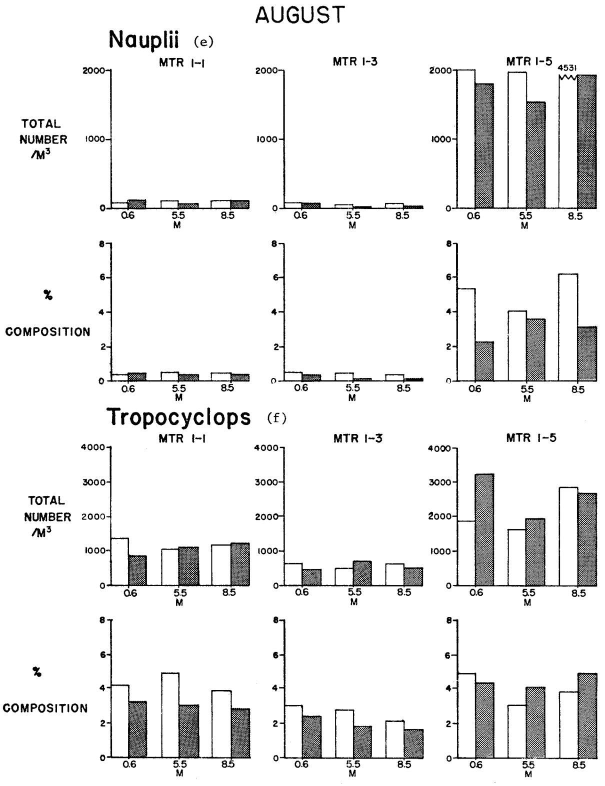


FIG. 36 continued. (e) Nauplii; (f) *Tropocyclops prasinus mexicanus*.

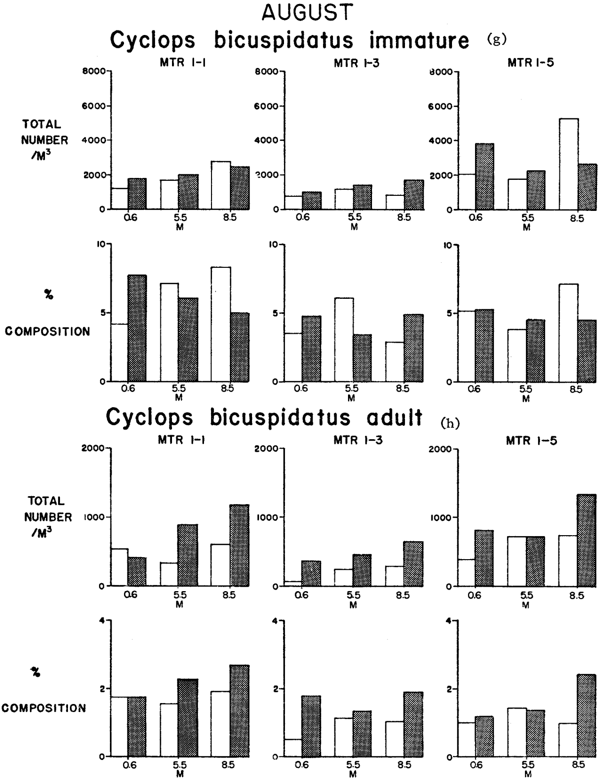


FIG. 36 continued. (g) Immature and (h) adult *Cyclops bicuspidatus*.

extreme, zooplankton could have been homogeneously distributed at 5 or 8 sampling locations while only one location had larger or smaller zooplankton abundances. At the other extreme, zooplankton could have had dissimilar abundances at all of the 6 or 9 locations.

The first step in selecting a representative sampling location is to compute the mean abundance of zooplankton in the forebay ($\bar{x}_F$) and then compare this to the mean abundance of zooplankton at each of the 6 or 9 grate-depth sampling locations ($\bar{x}_{g,d}$). Differences ($d,_{g,d}$) can be expressed either in abundance units or in percentages (percentage of $d,_{g,d}$ of the forebay mean). As the concentration of zooplankton varies from month to month, the differences ($d,_{g,d}$) are expressed as percentages. Calculations were done for the 6 locations in May and 9 in August. In order to compare the May and August results, calculations were also made for August for 6 locations only (deleting grate MTR 1-3, Table 10).

Calculations in Table 10 indicate that some locations consistently had higher zooplankton abundances than the forebay mean (e.g., MTR 1-5, 0.6 m) while others had lower mean abundances (e.g., MTR 1-1, 5.5 m). The $d,_{g,d}$'s varied from May to August and were dependent upon number of grates examined.

Two locations had mean abundances which were consistently closest to the forebay mean abundance. Location MTR 1-1, 8.5 m, had a location abundance 2.9% lower than the forebay abundance in May, 0.5% higher in August for 9 locations, and -12% in August for 6 locations. However, this location is near the forebay bottom and, while a fairly representative sampling location for the forebay mean, is not a suitable area from which to sample for various technical reasons. Large pieces of debris apparently drift along the forebay bottom and do on occasion clog the check valves on the intake hoses. Sand and gravel apparently pile up at the north end of the forebay; samples could be collected at 10.0 m at MTR 1-5 but the maximum sampling depth in August at MTR 1-1 was 8.5 m. In the future, this maximum sampling depth at MTR 1-1 may become shallower.

Location MTR 1-5, 5.5 m, had a location mean 2.1% above the forebay mean in May, 24.6% above the forebay mean in August for 9 locations, and 8.6% above the forebay mean for 6 locations. These values deviate more

TABLE 10. Difference ($d_{g,d}$) between location mean ($\bar{x}_{g,d}$) and forebay mean ($\bar{x}_F$), both in abundance units (animals/m^3) and as a percentage of the forebay mean, for the heterogeneity studies of May and August 1974.

Meters	MTR 1-1	MTR 1-3	MTR 1-5
May results (6 locations)			
0.6	-1,613 (-22%)		+1,898 (+25%)
5.5	-711 (10%)		+157 (+2.1%)
8.5	-217 (-2.9%)		+484 (+6.5%)
August results (6 locations)			
0.6	-16,454 (-37%)		+12,813 (+29%)
5.5	-15,309 (-34%)		+3,839 (+8.6%)
8.5	-5,591 (-12%)		+20,704 (+46%)
August results (9 locations)			
0.6	-10,645 (-27%)	-18,020 (-46%)	+18,622 (+48%)
5.5	-9,500 (-24%)	-8,973 (-23%)	+9,648 (+25%)
8.5	+218 (+0.5%)	-7,857 (+20%)	+26,513 (+68%)

widely from the forebay mean than the values calculated for MTR 1-1, 8.5 m; however MTR 1-5, 8.5 m, is a technically better sampling location. While it provides an overestimate of zooplankton abundances in the forebay, this gives a safety factor in calculations of numbers of zooplankton passing through the power plant.

CALCULATIONS OF CONFIDENCE LIMITS FOR $d_{g,d}$

The upper and lower 95% confidence limits for the true differences at a single sample location can be calculated from the following equation:

$$d_{g,d} \pm t_{.05[\nu]}\sqrt{\frac{MS(p-1)}{pm}}$$

where $d_{g,d} = \bar{x}_{g,d} - \bar{x}_F$

MS = within cell variance (error mean square)

p = no. of levels (6 in May, 6 or 9 in August)

m = number of observations at each level (8 in May, 4 in August)

ν = degrees of freedom within cells (23 in May with one missing data value, 18 or 12 in August)

t = Student's t

The above expression can be derived from formulae given by Kirk (1968, p. 74-76). Confidence intervals were calculated for the 6 locations in May and the 6 or 9 in August.

If the upper and lower confidence limits are added and subtracted from $d_{g,d}$ and the resulting interval contains the value zero, then the location mean is not significantly different (at the 95% level) from the forebay mean. If the interval does not contain the value zero, then the location mean is significantly different from the forebay mean.

The results of the calculations of the 95% confidence limits for the May and August sampling series and at location MTR 1-5, 5.5 m were:

May (6 locations) = +2.1% $\pm$ 14.4%

August (6 locations) = +8.5% $\pm$ 29.3%

August (9 locations) = +24.6% $\pm$ 30.8%

These indicate that the single location mean ($x_{MTR\ 1-5,\ 18'}$) was not significantly different from the forebay mean (x_F). Therefore this location can be considered a representative sampling location for the forebay.

Table 11 shows for each of the 6 or 9 locations in May and August whether the location mean was significantly (95% confidence level) greater or smaller than the forebay mean or whether it was equal to the forebay mean. As expected, means at MTR 1-1 were equal to or smaller than the forebay mean while means at MTR 1-5 were equal to or greater than the forebay mean. There was no apparent trend with depth. Since the comparisons shown are not orthogonal, the t-statistics are not independent. The significance tests do not have simultaneous meaning, but the results

TABLE 11. Locations and times in which the location mean was greater than, less than, or equal to the forebay mean.

Sampling locations	Depth	May (6 locations)	August (6 locations)	August (9 locations)
MTR 1-1	0.6 m	<	<	=
MTR 1-1	5.5 m	=	<	=
MTR 1-1	8.5 m	=	=	=
MTR 1-3	0.6 m			<
MTR 1-3	5.5 m			=
MTR 1-3	8.5 m			=
MTR 1-5	0.6 m	>	=	>
MTR 1-5	5.5 m	=	=	=
MTR 1-5	8.5 m	=	>	>

are presented nevertheless for information purposes.

CONCLUSIONS

The sampling locations MTR 1-5, 5.5 m, and MTR 1-1, 8.5 m, had mean zooplankton abundances which were not significantly different (95% confidence limit) from the mean abundance of zooplankton in the forebay. MTR 1-5, 5.5 m, was selected as the best sampling location as it avoided many of the technical problems associated with sampling at 8.5 m.

Zooplankton varied in abundance over a 24-hr period primarily due to diel changes in the vertical distribution of several taxa of zooplankton. Variations may also have occurred when different water masses, each with its own composition of zooplankton, flowed past the plant's intakes. However, since the postoperational study plan includes sampling for zooplankton abundance estimates at sunset, midnight, sunrise, and noon, a reliable estimate should be obtained of the mean abundance of zooplankton in the forebay during that particular sampling day.

SECTION 5
MORTALITY STUDIES OF FOREBAY ZOOPLANKTON

INTRODUCTION

An important part of the zooplankton study is the determination of numbers and species composition of zooplankton which are killed by condenser passage. This is accomplished by determining the percentage of zooplankton which are dead in the discharge-bay waters and in the forebay waters; from the difference in the two values one can calculate the percentage of zooplankton which are killed during condenser passage.

There are two technical problems to be overcome in such a study. First, an apparatus needs to be designed which collects zooplankton with a minimum amount of damage being inflicted during the collection process. Secondly, a procedure must be developed which rapidly distinguishes between living and dead zooplankton for mortality determinations.

METHODS AND MATERIALS

The forebay and discharge bay are challenging areas from which to sample zooplankton. Water circulates through these areas at high velocities and this plus the limited physical accessibility precludes the use of conventional sampling gear such as plankton nets.

Water pumps of various kinds have been used for years by limnologists and oceanographers to collect zooplankton (Aron 1958; O'Connell and Leong 1963; Leong 1967; Beers et al. 1967) and have recently been used in some power plant studies. Centrifugal pumps have been used more commonly in oceanography, possibly because they collect continuous samples (in space and time). These pumps have a motor-driven impellor which draws water through the pump at a continuous rate. This contrasts with a diaphragm pump; water is drawn in gushes through a flexible chamber which contracts and expands with the strokes of a piston which forms part of the roof of the chamber.

There are no articles currently available in the literature which compare the mortality of zooplankton collected with a centrifugal pump

and with a diaphragm pump. A diaphragm pump was selected for this study because it was thought that the possibility existed that zooplankton would be damaged on the impellor blades of the centrifugal pump.

The sampling apparatus was designed to collect zooplankton both for abundance estimates and for the mortality study. Water was drawn up through a 7.6 cm diameter hose and passed through the pump into a barrel of water. A 50 cm net (158µ mesh) was suspended in the barrel and excess water passed through an outlet pipe at the bottom of the barrel; the pipe was equipped with a flowmeter.

Sampling and handling techniques were tested in May 1974 and high mortalities of forebay and discharge-bay zooplankton were observed. Several studies were made in the summer of 1974 and through the winter of 1975 in which various modifications were tested. Results of some of these studies are reported briefly in this section.

DISCUSSION

8 May 1974

The first mortality study was conducted on 8 May 1974. Single 2-min samples were collected at grate MTR 1-6 (5.5 m) in the forebay and in the discharge bay; samples were collected at 0200, 0900, 1400, and 2100. Water was circulating through the Cook plant condensers at this time although heat was not being added.

Each sample was reduced to approximately 100 organisms by using the Folsom plankton splitter. The subsample was placed in a circular counting dish and the zooplankton were examined through a Bausch and Lomb Stereozoom microscope at a magnification of 20X to 140X. Zooplankton which exhibited no body or visceral movement were counted as dead and removed. The "live" and "dead" subsamples were preserved with Koechie's fluid (a sugar-based formalin solution) and later examined in Ann Arbor for species composition and abundance.

Care was taken to minimize the methodological sources of damage. Formalin-free glassware was used at all times. The Folsom plankton splitter was new and had never been exposed to formalin, the major and

only toxic constituent of Koechie's fluid. Samples were handled in a formalin-free room and were preserved in a second room.

Table 12 shows the results of the study. Forebay and discharge bay zooplankton mortalities were high and were variable from one time to another. The mean mortality of the discharge bay zooplankton was slightly higher than that for the forebay zooplankton, but this difference was not statistically significant.

The high mortality of zooplankton could have been associated with the actual collecting technique or with the handling techniques in the laboratory.

21 and 22 May 1974

On these dates, zooplankton were collected using two different sampling methods; the same handling techniques were used in the laboratory. Two vertical net hauls (50 cm diameter, 158μ mesh) were made in the forebay and two in the discharge bay (the plant was not circulating water). A fifth haul was made in the lake in 9.1 m of water. A single sample was collected in the forebay and in the discharge bay by using the diaphragm pump.

TABLE 12. Results of 8 May 1974 determinations of the mortality of zooplankton in the forebay and in the discharge bay at 4 sampling times. Numbers in parentheses refer to the total numbers.

	Zooplankton mortality (%)	
Time	Forebay	Discharge bay
0200	80 (415)	76 (293)
0900	66 (147)	55 (188)
1400	51 (132)	75 (161)
2130	67 (77)	68 (112)

Mortalities of zooplankton (Table 13) collected with the net were low in the lake and in the forebay. Mortalities were very high in the discharge bay, and more than half of the sample consisted of decayed zooplankton. Only fresh-looking zooplankton were counted, but mortalities were still over 30%.

Mortalities of zooplankton collected with the diaphragm pump in the forebay were higher than those of zooplankton collected with the vertical net haul. Discharge bay mortalities were not reliably estimated because of the large percentage of dead and dying zooplankton.

This study indicated that handling techniques in the laboratory were probably not responsible for the high mortality of zooplankton collected on 8 May 1974, but rather that it was associated with the collecting techniques.

9 and 10 July 1974

Further attention was focussed on the collecting procedure. The initial investigation was a comparison of the mortality inflicted on zooplankton by a vertical net haul and by a diaphragm and centrifugal

TABLE 13. Results of the 21 and 22 May 1974 study comparing the mortality of zooplankton collected by a vertical net haul with that of zooplankton collected with the diaphragm pump. Numbers in parentheses refer to total number of zooplankton examined; old zooplankton carcasses were not counted.

Sampling method and location	Mortality (%)		
	Replicate A	Replicate B	Mean
Vertical haul, lake	12 (242)	11 (324)	11.5
Vertical haul, forebay*	13 (388)	16 (470)	14.5
Vertical haul, discharge bay*	42 (159)	33 (203)	37.5
Diaphragm pump, forebay*	37 (406)	x	37
Diaphragm pump, discharge bay*	43 (338)	x	43

* Circulating pumps not running.

pump. The centrifugal pump used had the same pumping rate (50 gal/min) as the diaphragm pump. However, the intake hose was 5.1 cm in diameter in comparison with 7.6 cm for the diaphragm pump and thus the velocity of the water within the hose was somewhat greater.

Approximately 100 gal of filtered forebay water was put in a holding tank. For each test, a vertical haul was made in the forebay and the sample was split in half. One subsample served as the control. The second was placed in the holding tank, and the water was removed either by using the diaphragm or centrifugal pump. The net was, as in May, suspended in a barrel of water. This sample and the control sample were then examined in the laboratory and the mortality of the zooplankton determined.

Table 14 shows the results of this study. There was no decrease

TABLE 14. Results of the 9 and 10 July study comparing the mortality of zooplankton collected from a holding tank by a diaphragm pump and by a centrifugal pump. For each sample, 2 subsamples were examined. Numbers in parenthesis refer to total number of zooplankton examined.

		Zooplankton mortality (%)		
Pump		Holding tank	Net haul (control)	Difference
Diaphragm	Rep 1	68.5 (496)*	14.0 (1,200)**	54.5
	Rep 2	56.0 (1,423)*	22.5 (2,388)	33.5
	Mean	62.3	18.3	44.0
Centrifugal	Rep 1	72.5 (375)*	10.5 (1,735)	62.0
	Rep 2	56.0 (408)*	9.5 (1,157)	47.0
	Mean	64.5	10.0	54.5

* Holding tank not drained completely. This may account for the differences in the total numbers of zooplankton examined between those in the holding tank and those in the control.

** One subsample only.

in zooplankton mortality when a centrifugal pump was used instead of a diaphragm pump.

23 and 24 July 1974

Two methods were tried to reduce the mortality of zooplankton. Attention was focussed on minimizing the damage inflicted on the zooplankton when they were impinged upon the net.

Some of the velocity of the water from the pump is reduced when the net is suspended in a barrel of water. The original design had water passing out through the bottom of the barrel, probably creating turbulences along the entire length of the net. An alternate method was to close the outlet pipe and allow the excess water to flow out over the sides of the barrel. This technique has been used by Davies and Jensen (1974)

The second method was to partially fill a 50-gal barrel with filtered water, place the net at the bottom, fill the barrel with water from the pump, and then draw the net up through the barrel (the net had a slightly smaller diameter than that of the barrel). This technique had the advantage that pumped zooplankton were not retained within the relatively close confines of the net during the sampling period.

Samples were collected in the forebay at MTR 1-1 and at 5.5 m. Mortalities of zooplankton (Table 15) were slightly lower when water was pumped into a partially filled barrel of water, but mortalities were still high and were not comparable with net haul mortalities.

August Studies

The results of the May heterogeneity study (Section 4) had indicated that zooplankton were heterogeneously distributed in the forebay. The factor or factors which caused the heterogeneous distribution of zooplankton in the forebay were not determined. One possibility was that the water flowed in eddies in various regions of the forebay and that large numbers of dead zooplankton accumulated in these areas. Alternatively, dead zooplankton drawn into the power plant may have settled out at various depths as the water flowed through the intake pipes.

TABLE 15. Results of the 23 and 24 July study comparing mortalities of zooplankton collected with a diaphragm pump by 1) suspending a net in a barrel of water and allowing the pumped water to flow over the sides of the barrel during the 2 min sampling procedure, and 2) placing the net at the bottom of the partially filled barrel of water, filling the barrel with water from the pump, and then drawing the net up through the water. Numbers in parentheses refer to total numbers of zooplankton counted.

Method		Zooplankton mortality (%) Subsample A	Subsample B	Mean
Water over side	Rep 1	47 (364)	40 (232)	43.5
	Rep 2	41 (478)	40 (366)	40.5
	Mean	44	40	42.0
Net in barrel	Rep 1	36 (370)	30 (456)	33.0
	Rep 2	26 (161)	34 (138)	30.0
	Mean	31	32	31.5

This may have resulted in the occurrence of large numbers of dead zooplankton at various depths in the forebay. Secondly, if samples for mortality estimates were collected in such areas, this would have resulted in extraneously high zooplankton mortality estimates. In order to test for this, studies were conducted to determine whether the proportions of dead zooplankton were heterogeneously distributed in the forebay.

Two studies were conducted in August which examined the mortality of zooplankton at 0.6 m, 5.5 m, and 8.5 m. Results of the first study suggested that the mortality of zooplankton increased with depth at grate MTR 1-5. However, when this study was repeated a week later, similar mortalities (mean 33% of 6 samples) were obtained at all depths.

November Study

Differences in zooplankton mortalities between grates was not examined until November when construction of the discharge bay on Unit 1 was completed. These studies were inconclusive, in part because of the high

variability of the data and in part because a storm was in progress during the sampling. The storm apparently stirred up the bottom, for large numbers of dead zooplankton were drawn into the plant. The studies suggested that mortality may have varied between grates but these differences could not account for the high mortality of the zooplankton which had been observed consistently with all sampling techniques.

22 January 1975

Results of the November study led to the decision to design a new sampling apparatus based on a prototype developed by Icanberry and Richardson (1973) and used with slight modifications by Industrial Bio-Test Laboratories (1974). The design of the apparatus, called the "zaggot trap," is shown in Figure 37. The sampler is first filled with water and then the net is lowered into the water and the lid closed. Water is then sucked through the sampler by the diaphragm pump.

Mortalities of zooplankton are reduced largely because the velocity of water in the intake hose is greatly reduced when it enters the body of the sampler. In a barrel of water, some of the energy is dissipated through turbulences generated largely at the air-water interface, but a large amount of the energy is reduced on impact with the net. In the closed sampler, there is no air-water interface and the velocity of the pumped water is quickly reduced by the large volume of the water in the sampler. The velocity of water is reduced from 75.5 cm/sec in the hose to 2.0 cm/sec in the net. This is accomplished by the net having a larger diameter (47 cm) than the hose (7.6 cm).

The sampler may also reduce damage to the zooplankton because it is located between the pump and the intake hoses. Zooplankton are sampled before passing through the pump. Some of the observed high mortalities may have been inflicted on the zooplankton during their passage through the pump.

The system was modified from the original design of Icanberry and Richardson (1973). The sampler was made wider in order to further reduce the velocity of the water passing through the net. As the sampler is used in conjunction with a diaphragm pump (rather than the centrifugal

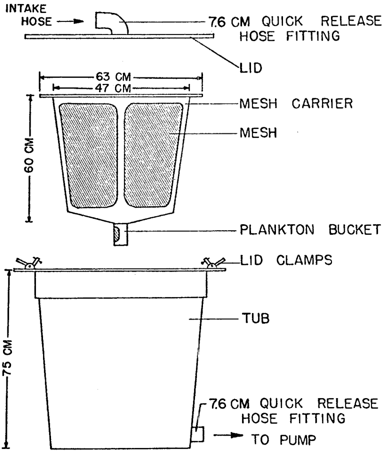


FIG. 37. Schematic view of the zooplankton sampler (Zaggot Trap) used in mortality studies in the forebay and discharge bay areas.

pump used by Icanberry and Richardson and by Bio-Test), a damper was placed in the system to reduce the surging of water through the net. A check-valve was installed at the bottom of the intake hose. The sampler could then be back-filled with water from the pump and hose connections reversed while water was retained in the system.

Table 16 shows the results of the January study. The mean mortality was 12% and, apart from sample 3, the variability among samples was small. This sampler has been used on subsequent studies and continues to inflict minimal damage on the zooplankton. It does

TABLE 16. Results of the 22 January 1975 study which determined the mortalities of zooplankton collected with the Zaggot Trap. Numbers in parentheses refer to the total number of zooplankton examined.

	Zooplankton mortality (%)		
Sample	Subsample A	Subsample B	Mean
1	12 (92)	14 (96)	13.0
2	8 (50)	12 (67)	10.0
3	15 (93)	19 (86)	17.0
4	24 (72)	6 (78)	15.0
5*	16 (61)	11 (72)	13.5
6	10 (67)	8 (108)	9.0
7	11 (113)	9 (89)	10.0
Mean	12.3	12.7	12.5

* Collection period was one-half minute.

not, however, collect quantitative samples and is more costly in time and personnel to use than the original apparatus. The zooplankton were collected from the forebay (MTR 1-5, 5.5 m of water, circulating pumps running) with the diaphragm pump; the collecting time was one minute.

The original apparatus will be used to collect samples for abundance and species composition estimates from the discharge bay. The new apparatus will be used in the forebay and in the discharge bay to collect samples for zooplankton mortality estimates. A representative location in the forebay has not yet been determined. While it does not seem likely that the percentage mortality of zooplankton will vary with depth or among grates, this has yet to be confirmed.

MORTALITY ASSESSMENTS AND COUNTING TECHNIQUES

Various techniques were tested to rapidly assess the mortality of zooplankton. In May, when 200 zooplankters were examined and counted to species, it took over 1 hr to process a sample. This has been modified

now so that approximately 100 organisms are examined at a time, dead ones are counted and removed, live ones preserved and counted, and the two subsamples later recounted in Ann Arbor to the species level. This technique has the advantage that mortality estimates are quickly available and further samples can be collected if the variability between samples is high. Usually three people can process up to 12 samples a day (2 subsamples counted for each) in addition to collecting samples for abundance estimates and setting up incubation experiments.

The use of a vital dye to distinguish between live and dead zooplankton would save time in the laboratory and would allow more samples to be collected than is now technically feasible. Dyes were tested throughout the summer and some have shown some promise, but none of the dyes were reliable. Several dyes were selected for testing, based on earlier experiments of Morgan (1973). Fifty live zooplankton were placed in a beaker containing a 0.50% concentration of the dye dissolved in water. Fifty zooplankton were heat-killed and placed in a second beaker. The dye was washed from the zooplankton 30 min later. Live and dead zooplankton were then examined under the microscope for the presence of the dye.

1) Rose Bengal killed over 10% of the zooplankton (*Cyclops bicuspidatus* and *Diaptomus*). However, it did not stain dye-killed zooplankton, heat-killed zooplankton, nor living zooplankton.

2) Janus Green, at the concentration used, killed half the zooplankton. These dye-killed zooplankton were not stained, and heat-killed zooplankton were only slightly stained. Living zooplankton did not take up the stain.

3) Fast Green killed 12% of the zooplankton; these zooplankton were not stained. Heat-killed zooplankton were only lightly stained.

4) Azure A killed 25% of the zooplankton. These zooplankton took up the stain as did heat-killed and living zooplankton.

5) Nile B killed and stained all the living zooplankton. All heat-killed zooplankton were stained. At lower concentrations the dye may be non-toxic and may stain only dead tissue. However, this was not investigated.

6) Toluidine Blue killed 40% of the zooplankton. Dye-killed *Diaptomus* spp. took up the stain while *Cyclops bicuspidatus* did not. All heat-killed zooplankton were stained. This dye may be useful at lower, less toxic concentrations. Some further investigations would need to be conducted on dye uptake by dead cyclopoids.

7) Erythrosin B was tested extensively. The dye is not toxic to living zooplankton at a concentration of 0.005%. Freshly killed copepods and cladocerans stain rapidly while cyclopoid copepods must be dead for several hours before they take up the stain. Therefore if a zooplankton sample were taken from the lake and stained, all dead cladocerans and calanoid copepods would take up the stain. Only cyclopoid copepods which had been dead for at least several hours would stain. This is of interest because it allows estimates to be made of the proportion of cyclopoids killed during collection and the proportion which were already dead. As zooplankton may not exhibit visual signs of decay until several days after death (Wheller 1967), it is sometimes difficult to distinguish between freshly killed and "old-dead" zooplankton. As zooplankton death rates have been estimated as high as 0.3-0.5 of the population/day (Edmondson 1960; Tappa 1965), it was thought that a large fraction of the zooplankton counted as dead in the intake mortality samples may have been zooplankton that were already dead at the time of collection.

On 23 July 1974, several zooplankton samples were collected for mortality estimates. One subsample was visually examined and the number of dead zooplankton determined. A second subsample was placed in the dye for 1 hr and then washed and preserved. When the sample was examined 6 days later, it was observed that the dye retention was poor and lower proportions of *Diaptomus* spp., *Cyclops bicuspidatus*, *Eurytemora affinis*, *Bosmina*, *Chydorus*, and nauplii were stained than were counted as dead in the visually examined subsample.

Subsequent studies in the laboratory indicated that the addition of acetic acid to the washed sample to give a final pH of approximately 4 to the preserved solution aided in dye retention. Samples were again collected from the forebay on 6 August 1974. Water was pumped into a partially filled barrel of water for 30 sec; a net lying at the bottom

of the barrel was then pulled up through the water. One subsample was visually examined for dead zooplankton while the second was treated with Erythrosin B as in July except that a few drops of acetic acid were added when the sample was preserved. The samples were examined 3 days later.

Mean zooplankton mortalities were estimated at 30% (Table 17) by the visual and the dye methods. Estimated mortalities for calanoid copepods and cladocerans were higher while estimated mortalities for nauplii and cyclopoid copepods were lower with the dye method than with the visual observation method. Cyclopoid mortality estimates were expected to be lower with the dye method, as earlier experiments in the laboratory had

TABLE 17. Results of 6 August 1974 study which compared techniques for estimating the percentage mortality of zooplankton. Numbers in parentheses refer to total number of zooplankton examined. V = visual method, D = dye method.

Sample	Depth (m)	Method	Zooplankton mortality (%) Cyclopoid	Calanoid	Nauplii	Cladocerans	Total*
1	0.5	V	28 (75)	30 (37)	49 (57)	12 (113)	27 (288)
		D	7 (41)	12 (17)	13 (23)	11 (58)	10 (146)
2	0.6	V	12 (73)	18 (33)	18 (33)	2 (203)	8 (348)
		D	5 (60)	0 (13)	6 (48)	8 (287)	6 (410)
3	5.5	V	19 (54)	15 (27)	22 (18)	24 (111)	21 (215)
		D	39 (36)	71 (7)	50 (12)	22 (125)	29 (181)
4	5.5	V	67 (27)	65 (17)	83 (6)	22 (87)	39 (140)
		D	69 (16)	93 (14)	75 (4)	32 (108)	47 (150)
5	8.5	V	63 (40)	45 (22)	18 (17)	22 (116)	30 (211)
		D	43 (54)	39 (31)	13 (24)	31 (108)	35 (235)
6	8.5	V	82 (28)	92 (13)	53 (17)	37 (102)	36 (162)
		D	67 (24)	75 (4)	67 (3)	51 (87)	55 (118)
Mean		Visual	45	44	41	20	30
		Dye	38	48	37	26	30

* Total number includes *Asplanshna* spp., a rotifer.

indicated that freshly heat-killed cyclopoids do not stain. The estimated mortality of cyclopoids by the dye method was 38%, which suggested that a large fraction of these zooplankton were already dead before collection. This was somewhat surprising as Industrial Bio-Test Laboratories (1972) obtained intake mortalities of less than 20% in August. An alternate explanation of the high percentage of stained cyclopoid copepods is that the collection process was so mechanically damaging to these zooplankton that the dye was rapidly absorbed into the cepthalothroax and antennules.

The dye was again tested on 14 August. Results of the study were not as encouraging as those of the previous study. Total zooplankton mortalities (Table 18) were estimated at 34% with the visual method and 41% with

TABLE 18. Results of the 14 August 1974 study which compared techniques for estimating the percentage mortality of zooplankton. V = visual method, D = dye method. Numbers in parentheses refer to total number of zooplankton examined.

Sample*	Depth (m)	Method	Zooplankton mortality (%)				
			Cyclopoid	Calanoid	Nauplii	Cladocerans	Total**
1	0.6	V	51 (224)	37 (27)	4 (24)	25 (83)	41 (361)
		D	38 (134)	64 (25)	50 (18)	31 (72)	39 (249)
2	0.6	V	29 (270)	36 (53)	19 (42)	9 (260)	22 (728)
		D	44 (272)	53 (49)	67 (24)	18 (144)	39 (491)
3	5.5	V	63 (273)	66 (62)	51 (53)	7 (388)	35 (780)
		D	18 (142)	25 (24)	38 (26)	14 (191)	19 (388)
5	8.5	V	52 (219)	67 (36)	41 (34)	14 (187)	37 (480)
		D	90 (164)	73 (30)	100 (19)	25 (136)	65 (349)
Mean	Visual		49	52	29	14	34
	Dye		48	54	64	22	41

* Results of the determinations from samples 4 (5.5 m) and 6 (8.5 m) are not presented, as most of the zooplankton in the dyed subsamples were heavily stained and all zooplankton were stained to some extent thus making live-dead separations extremely subjective.

** Total includes the rotifer *Asplanchna* spp.

the dye method. Almost all the zooplankton were stained to some extent and only darkly stained zooplankton were counted as "dead." Nevertheless, a larger fraction of nauplii, calanoid copepods, and cladocerans were estimated as dead by the dye method than by the visual method. Cyclopoid copepod mortality estimates were similar with the two methods. The reason why the zooplankton took up the dye in excessive amounts was not determined; nor was it determined why cyclopoids killed during the collection process apparently took up the dye more readily than heat-killed cyclopoids. No further studies have been made on the use of vital dyes since the 14 August study.

SUMMARY OF RESULTS

1) A new sampler has been designed for estimating the mortality of zooplankton in the forebay and in the discharge bay. It inflicts minimal damage on zooplankton, and the variability in the mortality of zooplankton between samples is low. The apparatus is not useful for abundance estimates; the original sampler described by Stewart (1974) and in Section 1 of this text will be used for this phase of the entrainment studies.

2) Studies have not yet conclusively determined whether or not the mortality of forebay zooplankton varies with depth and between grates.

3) Vital dyes may be useful in the mortality studies, particularly Erythrosin B, although further investigations need to be made. At present, with one sampling location in the forebay and one in the discharge bay, and two sampling times, three people can visually process the 4 samples (8 subsamples counted) collected the morning, and in the afternoon, and examine the 8 6-hr incubation subsamples. If samples must be collected from more than one location in the forebay, it may become necessary to employ an alternate technique to assess zooplankton mortalities. The use of a vital dye is the most promising alternative.

SECTION 6

THE EPIBENTHIC ZOOPLANKTON AT 6 METERS AND AT 9 METERS IN JULY 1974

INTRODUCTION

While both the zooplankton and the benthic communities are currently being studied as part of the Cook Nuclear Power Plant environmental investigations, there is a region of overlap between the two communities which is not currently being studied--the epibenthic zooplankton community. Although vertical net hauls are made at every zooplankton station from the lake bottom to the surface, the design of the net and its mode of operation make it impossible to sample those organisms living on the sediments or within approximately half a meter of the bottom.

The epibenthic zooplankton have not yet been investigated in Lake Michigan. They have, however, been studied in some Minnesota lakes (Cole 1955), Oneida Lake (Baker 1918), Lake Simcoe (Rawson 1930), Douglas Lake (Moore 1939) and a bog lake (Lindeman 1941). Both cladocerans and copepods have been found either living directly on the sediments or in the water just above the sediments.

Epibenthic cladocerans are for the most part herbivores and detritus feeders. Copepods are also detritus feeders and herbivores, although some forms are also carnivores. In the trophodynamics of the lakes in which the epibenthic zooplankton were studied, these copepods and cladocerans consumed the detritus which was produced mainly by the plankton and littoral vegetation and were in turn consumed by predaceous benthic organisms and fish.

The study of the epibenthic zooplankton has relevance to the Cook environmental study because: 1) The epibenthic zooplankton are a part of the aquatic community which may be subject to damage due to condenser passage and/or entrainment. 2) The epibenthic zooplankton may consume dead or damaged pelagic zooplankton. This may be of importance if a relatively large number of zooplankton are killed or injured during a condenser passage and settle out of the water column near the power plant. The epibenthic zooplankton may present a mechanism by which organic

matter is circulated back into the lake rather than accumulating in the sediments. 3) Epibenthic zooplankton may be a significant food source for the various fish and benthic organisms which occur in the nearshore area.

In order to further study the epibenthic zooplankton, a series of core collections were taken on 22 and 23 July 1974. Results of the study on the epibenthic zooplankton are reported in this section. The results of the study of the zoobenthic organisms are reported by Mozley (1975).

MATERIALS AND METHODS

Duplicate sediment cores were taken at 5 stations approximately aligned parallel to shore and 80 m apart in front of the plant site. The first series of stations was taken on the afternoon of 22 July 1974 and was located along the 6 m contour, approximate depth at which the discharge structures occur. The second series of 5 stations was taken on the morning of 23 July and was along the 9 m contour, the approximate depth at which the intake structures occur.

Lake conditions were rough with 0.6-0.9 m waves and strong winds. An upwelling was in progress during the entire sampling period. Deep water temperatures were not recorded but were probably close to 10°C (extrapolation from Fig. 25).

The samples were collected by scuba divers. A plastic core tube (46.4 cm long, 7.2 cm internal diameter) was pushed into the sediments to an approximate depth of 15 cm. The core was then removed and the tube stoppered at both ends. A second sample was collected within 3 m of the first and both cores were brought to the surface. The contents of each core tube were then transferred to a labelled plastic bag.

On shore, the contents of each plastic bag were transferred to a bucket and the water decanted off and poured through a plankton cod-end (#10 mesh window). The sediment was washed several times and the water quickly decanted off before the suspended organisms had time to settle out. The water and plankton were then transferred to a labelled jar and preserved with Koechies fluid.

The microcrustaceans were identified under a Bausch and Lomb stereozoom microscope. Only intact organisms were counted; broken or otherwise damaged organisms were assumed to have been settled out dead zooplankton and were not enumerated. Copepods, cladocerans and ostracods were generally counted to the species level.

RESULTS

Table 19 shows the mean abundances, standard deviations, and percentage compositions of the copepods, cladocerans, and ostracods which were enumerated. Abundances are expressed in numbers/m^3 in order that the data be comparable with the zooplankton survey and entrainment data. It was therefore assumed in these calculations that the epibenthic zooplankton occurred on or above the sediments. Although *Cyclops bicuspidatus* copepodites have been shown to burrow in the sediments during the summer (Cole 1955), they apparently do so just before they form cysts. As *C. biscuspidatus* were not observed in cysts in any of the samples, it is probably valid to assume that they also were not burrowing in the sediments. *Canthocamptus staphylinoides* and *Candona* spp. also burrow in the sediments (Moore 1939), but they accounted for only a small fraction of the total zooplankton examined.

Epibenthic zooplankton were more abundant at 9 m (279,685/m^3) than at 6 m (181,337/m^3). No vertical net hauls were made during the sampling series. However, zooplankton abundances at DC-1 were 42,560/m^3 on 11 July and 13,205/m^3 on 22 August (Section 4). These data suggest that the epibenthic zooplankton community was quite large. The mean abundance of zooplankton collected during the 6 August entrainment samples was only 39,109/m^3, which suggests that only a small fraction of the epibenthic zooplankton is subject to condenser passage. This may be due to the fact that these organisms live close to the bottom and so are not drawn into the power plant with the plankton.

The epibenthic zooplankton contained many species, most of which were only rarely collected during the regular survey cruises or in the entrainment samples. The majority of the species had, however, been previously captured in earlier collections.

TABLE 19. Mean abundances (numbers/m^3), standard deviations, and percentage compositions of epibenthic zooplankton collected in core samples from 6 m and 9 m on 22 and 23 July 1974.

	Station C: 6 m			Station D: 9 m		
Taxon	#/m^3	s	%	#/m^3	s	%
Copepod nauplii	17546	18237	9.7	4934	5210	1.8
Cyclopoid copepods						
immature	59767	38744	33.0	68619	25504	24.5
Cyclops bicuspidatus t.	3231	2562	1.8	9498	5369	3.4
Cyclops vernalis	19093	15538	10.5	53755	24335	19.2
Eucyclops agilis	6110	9333	3.4	8930	6126	3.2
Paracyclops fimbriatus p.	3212	5069	1.8	8851	2217	3.2
Tropocyclops prasinus	0	0	0.0	157	495	0.1
Calanoid copepods						
immature *Diaptomus*	1958	1963	1.1	2037	1817	0.7
Diaptomus ashlandi	705	578	0.4	1097	919	0.4
immature *Eurytemora*	1410	1095	0.8	3995	3682	1.4
Eurytemora affinis	4935	4323	2.7	8538	5280	3.1
Harpacticoid copepods						
immature	157	330	0.1	548	743	0.2
Canthocamptus staphylinoides	1410	1912	0.8	2350	2688	0.8
Bryocamptus zschokkei	0	0	0.0	862	1135	0.3
Cladocerans						
Alona affinis	12455	23510	6.9	23108	17772	8.3
Alona spp.	11828	10975	6.5	39558	19924	14.1
Alonella sp.	2037	1779	1.1	2115	1773	0.8
Bosmina longirostris	14178	12842	7.8	1410	1643	0.5
Chydorus sphaericus	7755	7949	4.3	1880	1440	0.7
Daphnia retrocurva	78	248	0.0	0	0	0.0
Daphnia galeata m.	78	248	0.0	157	495	0.1
Eubosmina coregoni	78	248	0.0	0	0	0.0
Eurycercus lamellatus	12768	11949	7.0	23891	10334	8.5
Ilyocryptus sordidus	157	495	0.1	3212	7287	1.1
Leydigia quadrangularis	78	248	0.0	940	2708	0.3
Polyphemus pediculus	157	330	0.1	0	0	0.0
Ostracods						
Candona sp.	78	248	0.0	9243	20235	3.3
Total	186195	109470		280663	97963	

Nauplii were more abundant at 6 m (17,546/m^3) than at 9 m (4,934/m^3). The abundance of nauplii at 9 m was similar to abundances in the July and August survey samples and the August entrainment samples. Nauplii, however, were considerably more abundant in the 6 m core samples than in any of the plankton samples. While nauplii were not enumerated to the species level, most of the nauplii may have been cyclopoids. Adult and immature cyclopoid copepods dominated the copepods and *Cyclops bicuspidatus, C. vernalis, Eucyclops agilis,* and *Paracyclops fimbriatus* females were often observed carrying eggs. Some nauplii may also have been produced from resting eggs of *Epischura lacustris* (Selgeby 1975). This species was rarely observed in the July zooplankton, but occurred in large numbers in the August plankton samples. *Eurytemora affinis* may also have produced nauplii towards the end of July.

Adult *Cyclops bicuspidatus* were more abundant at 9 m (9,493/m^3) than at 6 m (3,231/m^3). Abundances were somewhat higher than in the July and August survey and in the entrainment samples.

Cyclops vernalis adults were collected in large numbers, with more animals being caught at 9 m (53,755/m^3) than at 6 m (19,093/m^3). Adults were rarely captured during the July and August survey samples, and a maximum concentration of 500/m^3 was observed in a July nighttime entrainment sample. These data suggest that *Cyclops vernalis* remain on or very close to the bottom and do not enter the plankton in any large number, at least in Lake Michigan. Adults have been observed in large numbers in the plankton of Lake St. Clair (Leach 1973) and Lake Erie (Andrews 1953). Andrews indicated that *C. vernalis* has a short development time and matures from nauplius to adult in less than 2 weeks; thus he concluded it was possible to miss population peaks. At 10°C *C. vernalis* requires over 2 months to complete its development from egg to adult (Coker 1934) and at 20°C would require approximately one month. As bottom water temperatures were 10-24°C during July and August, it is unlikely that the study missed a population peak.

Immature cyclopoid copepods were not separated to species. Immatures were more abundant at 9 m (68,619/m^3) than at 6 m (59,762/m^3) and were considerably more abundant than in the July and August survey samples

and the July entrainment samples. Therefore a large fraction of these animals must remain close to the bottom during the day and night. Immatures probably consisted of *Cyclops bicuspidatus*, *C. vernalis*, *Eucyclops agilis*, and *Paracyclops fimbriatus*.

Eucyclops agilis and *Paracyclops fimbriatus* were more abundant at 9 m than at 6 m. They were not collected in the July and August survey samples nor in the July entrainment samples. Therefore they probably remain near or on the bottom and only rarely enter the plankton.

Tropocyclops prasinus mexicanus occurred in very low numbers (less than $157/m^3$) in the epibenthic plankton. It occurred in similar abundances as in the July and August survey samples and the July entrainment samples.

Immature and adult *Diaptomus* spp. were somewhat more abundant at 9 m than at 6 m. They occurred in similar abundances as in the July and August survey samples and in the July entrainment samples. *Diaptomus* spp., while a feature of the epibenthic fauna (Moore 1939), are largely planktonic and form only a small component of this bottom community.

Eurytemora affinis adults and immatures were more abundant at 9 m than at 6 m. They were also more abundant than in the July and August survey samples and the July entrainment samples. Adults were most abundant in the entrainment samples during the night. These data suggest that *E. affinis* remains close to or on the bottom during the day and that during the night some unknown fraction of the adults enters the plankton. Immatures may, in addition to the night, spend part of the day in the plankton.

Canthocamptus staphylinoides and *Bryocamptus* sp. were more abundant at 9 m than at 6 m. They were not collected during the July and August survey samples nor the July entrainment samples. This form probably only rarely enters the plankton. Some of the *C. staphylinoides* adults were observed in cysts.

Alona affinis, *Alona* spp., and *Alonella* sp. were more abundant at 9 m than at 6 m and accounted for 14-23% of the epibenthic zooplankton. They were not collected in the July and August survey and entrainment

samples. A few were taken in fish larvae collections made at night (Stewart 1974), but they accounted for only a small percentage of the total zooplankton. These species probably remain on or near the bottom during most of their lives and rarely enter the plankton.

Bosmina longirostris was more abundant at 6 m ($14,178/m^3$) than at 9 m and occurred in densities intermediate to those of the July and August entrainment and survey samples. *Bosmina* sp. have previously been observed in the epibenthic zooplankton (Moore 1939).

Chydorus sphaericus was more abundant at 6 m ($7,755/m^3$) than at 9 m ($1,880/m^3$). The cladoceran was also more abundant than in the July and August entrainment and survey samples. Baker (1918) and Rawson (1930) also collected *Chydorus* sp. in epibenthic samples.

Daphnia galeata mendotae, D. retrocurva, and *Eubosmina coregoni* were collected in low numbers. They were less abundant than in the July and August entrainment and survey samples and apparently form only a minor component of the epibenthic zooplankton.

Eurycercus lamellatus occurred in large numbers and accounted for over 7% of the epibenthic zooplankton. These cladocerans were more abundant at 9 m ($23,891/m^3$) than at 6 m ($12,768/m^3$). *E. lamellatus* was not collected in the July and August survey and entrainment samples, although some animals were collected in nighttime fish larvae samples (Stewart 1974). This cladoceran probably remains on or near the bottom with only a small fraction of the total population entering the plankton at night.

Ilycryptis acutiformis, I. sordidis, and *Leydigia quadrangularis* were more abundant at 9 m than at 6 m. However, they formed less than 2% of the epibenthic zooplankton. These cladocerans were not collected during the July and August survey and entrainment samples or in nighttime fish larvae collections (Stewart 1974). These species probably live on or near the sediments and do not enter the zooplankton.

Polyphemus pediculus was collected in low numbers at 6 m. Abundances were similar to those of the August survey samples. *P. pediculus* is probably not a regular or an important feature of the epibenthic zooplankton.

Ostracods were collected in low numbers at 6 m ($78/m^3$) but were abundant at 9 m ($9,243/m^3$) and formed over 3% of the standing stock of epibenthic zooplankton. They were not collected during the July and August survey cruises nor in the August entrainment samples. Stewart (1974) did not observe ostracods in his nighttime fish larvae collections. Ostracods probably remain close to or on the bottom and rarely enter the plankton.

Nematodes were also enumerated. Concentrations are expressed in numbers/m^2 because these forms probably do not enter the plankton but remain on or near the surface of the sediment. Nematodes do burrow in the sediments (Moore 1939) but to variable depths. Nematodes occurred in similar concentrations at 6 m ($59,000/m^2$) and 9 m ($57,100/m^2$). If the mean concentration of epibenthic zooplankton is expressed in numbers/m^3, there were $182,129/m^3$ at 6 m and $182,129/m^3$ at 9 m. Therefore the nematodes were approximately as abundant as the zooplankton at 6 m but were less abundant at 9 m. Fish eggs were enumerated. Eggs were more abundant at 6 m ($1,280/m^2$) than at 9 m ($910/m^2$).

DISCUSSION

Data collected from the core samples indicated that there was a large epibenthic zooplankton community at 6 m and an even larger epibenthic zooplankton community at 9 m. Concentration of these organisms was higher than the concentration of zooplankton which were collected during the July and August survey samples and the August entrainment samples. These data suggest that most of the epibenthic zooplankton community will not be subject to condenser passage, at least in August, as only a small percentage of the community apparently enters the plankton at night. As the thermal plume floats at the surface in the summer, it is unlikely that any of the epibenthic zooplankton will be subject to entrainment except possibly in the scour area around the discharge structures.

The dominant epibenthic microcrustacea were the cladocerans *Alona affinis*, *Alona* spp., and *Eurycercus lamellatus*. These forms are typical littoral organisms and are not a regular component of the plankton.

The dominant copepods were *Cyclops vernalis, Cyclops bicuspidatus, Eucyclops agilis,* and *Paracyclops fimbriatus*. All these taxa are apparently littoral forms, although *C. bicuspidatus* is also a member of the plankton. Some typical planktonic forms also occurred in the epibenthic zooplankton collections (*Bosmina longirostris, Chydorus sphaericus, Daphnia galeata mendotae, Eubosmina longirostris, Polyphemus pediculus, Diaptomus* spp.), although they formed a relatively small percentage of the total epibenthic plankton. These organisms were frequently as abundant in the epibenthic zooplankton collections as in the July and August survey and entrainment collections. The littoral *Ilyocryptis acutiformis, I. sordidus, Leydigia quadrangularis,* ostracods, *Canthocamptus staphylinoides,* and *Bryocamptus* sp. were all rare.

The epibenthic zooplankton species composition was similar at 6 and 9 m for most taxa, although most organisms were more abundant at 9 m. Nauplii were more abundant at 6 m. However, as cyclopoid copepods were more abundant at 9 m and as these adults are predaceous on nauplii, these differences in nauplii distributions are not necessarily unexpected. The more typical planktonic cladoceran (*Bosmina coregoni, Eubosmina longirostris, Daphnia retrocurva, Chydorus sphaericus*) were also more abundant at 6 m.

If condenser passage were lethal to a significant percentage of the zooplankton and if these forms settled out of the water column near the discharge structures, there would be a large epibenthic zooplankton and nematode community to consume these forms. In the summer months when cladoceran reproduction is rapid and many of the cyclopoid copepods are reproducing, there may be a rapid increase in the standing stock of these forms. It is unlikely that the dead organisms would settle out onto the bottom and slowly decompose; rather, they would probably be rapidly consumed and their organic matter returned to the food web.

Many of the fish species which were collected in the nearshore area by Jude et al. (1975) probably feed upon the epibenthic zooplankton. Alewife have been collected with such epibenthic zooplankton as *Eurycercus lamellatus, Sida* sp., harpacticoids, and ostracods in their stomachs

(Norden 1968; Morsell and Norden 1968; Rhodes 1971). Similarly, spottail shiners have been collected with such organisms in their guts (Basch 1968; Smith and Kramer 1964). Smelt, yellow perch, trout perch, and johnny darters feed upon the zooplankton when young and gradually feed upon the benthos as they increase in size (Scott and Crossman 1973). Various benthic organisms also consume the epibenthic zooplankton.

The epibenthic zooplankton were more abundant at 9 m than at 6 m. This could have been due to several factors. First, as was shown in Section 5, fish predation was apparently most intense close to shore, when larval and juvenile fish were concentrated in this region in the summer. Therefore the differences in abundance of the epibenthic zooplankton may have been associated with relatively intense fish predation at 6 m. Nematodes apparently escape fish predation as they were equally abundant at 6 and 9 m. This may be due to their burrowing habits or to the fact that once fish feed directly upon the benthos they select larger forms such as amphipods, mysiids, and chironomids.

Epibenthos zooplankton may also have been more abundant at 9 m than at 6 m because there may have been more detritus there. Observations made by scuba divers in the fall of 1973 indicated that patches of silt and detritus were observed more often in waters deeper than 10 m (Ayers and Seibel 1973).

SUMMARY

1) A large epibenthic zooplankton community existed at 6 m and 9 m in July 1974.

2) Epibenthic zooplankton were more abundant at 9 m than at 6 m.

3) Epibenthic zooplankton occurred in higher concentrations than zooplankton collected in entrainment samples in July or in vertical hauls collected during the survey cruises of July and August.

4) Epibenthic zooplankton were numerically dominated by forms which spent most of their life either on or near the sediments and which rarely entered the plankton. However, typical planktonic forms were also collected.

5) The data suggest that only a small fraction of epibenthic zoo-

plankton will be subject to either condenser passage or to entrainment.

6) Epibenthic zooplankton were composed of herbivores, detritus feeders, and carnivores. In the event that relatively large numbers of injured or killed zooplankton settle out from the plume near the discharge structures, the epibenthic zooplankton offer a means by which organic matter is returned back to the food web. As these forms have high reproductive rates in the summer, they may increase in standing stock in response to an increased food supply.

7) Epibenthic zooplankton are probably preyed upon quite heavily by fish in the inshore area. Epibenthic zooplankton may also be preyed upon by certain benthic organisms.

8) Epibenthic zooplankton may have been more abundant at 9 m than at 6 m because of the lower fish predation rate and larger amounts of detrital material that characterize the deeper portion of the study area.

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APPENDIX

Mean Abundance, Standard Deviation of the Mean, Percentage Composition and Dry Weight for Zooplankton Collected on 20 April, 15 May, 13 June, 11 July, 22 August, 12 September and 9 October 1974

TABLE 20. Mean abundance, standard deviation of the mean, percentage composition, and dry weight for zooplankton collected at 28 stations on 20 April 1974. Two samples were counted at each station.

Species	DC-2			DC-5			DC-6		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	1741	87	48.9	451	18	11.2	380	23	8.6
Cyclopoid copepods									
Cyclops C1-C5	657	83	18.4	459	78	11.4	635	41	14.4
Cyclops bicuspidatus thomasi	150	22	4.2	1743	342	43.3	2093	109	47.4
Cyclops vernalis	0	0	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	25	10	0.7	38	6	1.0	69	2	1.6
Calanoid copepods									
Diaptomus C1-C5	310	33	8.7	169	33	4.2	206	8	4.7
Diaptomus ashlandi	383	65	10.8	781	61	19.4	661	58	15.0
Diaptomus minutus	173	71	4.9	165	11	4.1	148	124	3.4
Diaptomus oregonensis	32	1	0.9	66	10	1.7	107	64	2.4
Diaptomus sicilis	0	0	0.0	58	6	1.4	61	23	1.4
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	5	5	0.1	0	0	0.0	0	0	0.0
Eurytemora affinis	9	9	0.3	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	17	11	0.5	85	4	2.1	54	16	1.2
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods									
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans									
Bosmina longirostris	31	10	0.9	12	4	0.3	0	0	0.0
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	3	3	0.1	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	6	0	0.2	0	0	0.0	0	0	0.0
Daphnia retrocurva	5	5	0.1	0	0	0.0	0	0	0.0
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	8	5	0.2	0	0	0.0	0	0	0.0
Holopedium gibberum	2	2	0.0	0	0	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers									
Asplanchna spp.	5	1	0.1	0	0	0.0	0	0	0.0
Total	3563	65		4029	450		4414	450	
Dry wt (mg/m^3)	-	-		-	-		**24**	**3.6**	
Dry wt (μg/individual)	-	-		-	-		**4**	**1.0**	

TABLE 20 continued. 20 April 1974.

Genus	SDC 4-3			SDC 4-4			SDC 7-1			SDC 7-3			SDC 7-5		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	500	258	15.4	382	175	19.5	515	96	51.0	1116	85	56.7	538	297	15.4
Cyclopoid copepods															
Cyclops C1-C5	224	66	6.9	312	124	15.9	217	39	21.4	274	30	13.9	276	126	7.9
Cyclops C6	1606	25	49.6	686	206	35.0	88	58	8.7	102	22	5.2	1608	820	46.1
Tropocyclops	14	5	0.4	42	16	2.1	9	6	0.9	23	8	1.2	36	17	1.0
Calanoid copepods															
Diaptomus C1-C5	100	7	3.1	133	30	6.8	67	7	6.6	136	33	6.9	215	119	6.2
Diaptomus C6	740	167	22.8	371	105	19.0	66	44	6.6	233	19	11.8	764	320	21.9
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	0	0	0.0	0	0	0.0	4	2	0.4	15	0	0.8	0	0	0.0
Eurytemora C6	0	0	0.0	0	0	0.0	1	1	0.1	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	16	3	0.5	31	15	1.6	0	0	0.0	1	1	0.1	32	6	0.9
Limnocalanus C6	1	1	0.0	1	1	0.1	0	0	0.0	1	1	0.0	4	4	0.1
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	1	0	0.1	0	0	0.0
Cladocerans															
Bosmina	31	7	0.9	1	1	0.1	8	8	0.8	26	12	1.3	11	4	0.3
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	0	0	0.0	0	0	0.0	0	0	0.0	4	1	0.2	0	0	0.0
Daphnia	5	0	0.1	0	0	0.0	6	4	0.6	9	4	0.5	1	1	0.0
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	2	2	0.1	0	0	0.0	12	12	1.2	1	1	0.0	0	0	0.0
Holopedium	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	0	0	0.0	0	0	0.0	18	12	1.8	25	9	1.3	0	0	0.0
Total	3240	484		1958	673		1011	15		1968	54		3485	1711	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		21	7.4	
Dry wt (μg/individual)	-	-		-	-		-	-		-	-		5	1.9	

TABLE 20 continued. 20 April 1974.

Genus	NDC 1-2			NDC 2-1			NDC 2-3			NDC 4-1			NDC 4-3		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	2194	589	48.3	659	86	59.1	1157	79	35.5	1359	149	47.0	1582	83	43.3
Cyclopoid copepods															
Cyclops C1-C5	694	87	15.3	174	34	15.6	641	7	19.7	574	66	19.9	374	129	10.2
Cyclops C6	197	117	4.3	82	0	7.4	427	8	13.1	479	149	16.6	583	59	16.0
Tropocyclops	42	2	0.9	19	10	1.7	18	0	0.6	52	10	1.8	18	2	0.5
Calanoid copepods															
Diaptomus C1-C5	333	3	7.3	66	1	5.9	198	22	6.1	159	43	5.5	233	65	6.4
Diaptomus C6	959	170	21.1	70	0	6.3	723	120	22.2	214	1	7.4	739	26	20.2
Epischura C1-C5	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	18	3	0.4	1	2	0.1	2	2	0.1	0	0	0.0	10	4	0.3
Eurytemora C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	33	18	0.7	3	3	0.3	25	7	0.8	5	3	0.2	17	3	0.5
Limnocalanus C6	5	5	0.1	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	1	1	0.1	1	1	0.0	1	1	0.0	1	1	0.0
Cladocerans															
Bosmina	30	5	0.7	20	4	1.8	31	4	1.0	11	4	0.4	50	7	1.4
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	4	4	0.1	0	0	0.0	5	3	0.1	4	4	0.1	2	2	0.1
Daphnia	22	14	0.5	14	11	1.2	23	0	0.7	17	2	0.6	26	2	0.7
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	12	9	0.3	3	3	0.3	5	0	0.1	15	4	0.5	1	1	0.0
Holopedium	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.0	1	1	0.0
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	1	1	0.0	3	3	0.3	2	2	0.1	0	0	0.0	14	14	0.4
Total	4544	989		1116	53		3259	15		2890	418		3652	5	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 20 continued. 20 April 1974.

Genus	SDC 1-1			SDC 1-2			SDC 2-1			SDC 2-3			SDC 4-1		
	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%
Copepod nauplii	755	80	57.5	1391	3	44.1	243	23	55.7	1228	28	40.0	357	11	59.4
Cyclopoid copepods															
Cyclops C1-C5	302	7	23.0	532	54	16.9	81	5	18.7	436	2	14.2	84	16	13.9
Cyclops C6	84	3	6.4	139	40	4.4	18	9	4.1	375	10	12.2	47	11	7.9
Tropocyclops	14	14	1.1	21	3	0.7	17	10	3.8	19	5	0.6	27	7	4.5
Calanoid copepods															
Diaptomus C1-C5	75	13	5.7	257	36	8.2	28	8	6.5	185	1	6.0	25	1	4.2
Diaptomus C6	48	20	3.6	752	47	23.8	25	15	5.8	723	105	23.5	30	1	4.9
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	5	5	0.4	3	0	0.1	2	0	0.5	20	12	0.6	9	1	1.4
Eurytemora C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	1	1	0.1	24	0	0.8	0	0	0.0	19	5	0.6	1	1	0.1
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	3	1	0.1	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina	17	5	1.3	21	21	0.7	19	10	4.3	40	16	1.3	11	2	1.9
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	1	1	0.1	1	1	0.0	1	1	0.3	2	2	0.1	4	1	0.7
Daphnia	5	2	0.4	11	5	0.4	1	1	0.1	13	8	0.4	1	1	0.2
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	8	8	0.6	3	3	0.1	1	1	0.1	2	2	0.1	3	3	0.4
Holopedium	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.1
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	0	0	0.0	0	0	0.0	0	0	0.0	3	3	0.1	1	1	0.2
Total	1313	143		3155	166		436	79		3071	135		601	25	
Dry wt (mg/m³)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 20 continued. 20 April 1974.

Genus	NDC 4-4			NDC 7-1			NDC 7-3			NDC 7-5			SDC.5-2		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	469	2	10.7	1759	178	48.7	2838	274	51.3	2139	669	36.5	1250	130	55.3
Cyclopoid copepods															
Cyclops C1-C5	611	72	13.9	546	22	15.1	975	90	17.6	390	127	6.7	501	6	22.1
Cyclops C6	1881	8	42.8	619	12	17.2	601	116	10.9	1915	303	32.7	145	15	6.4
Tropocyclops	94	4	2.1	46	13	1.3	16	3	0.3	34	7	0.6	16	5	0.7
Calanoid copepods															
Diaptomus C1-C5	235	30	5.4	260	30	7.2	348	33	6.3	194	5	3.3	152	5	6.7
Diaptomus C6	1039	295	23.7	330	26	9.1	662	23	12.0	1087	302	18.5	130	7	5.7
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	1	1	0.0	7	7	0.2	33	16	0.6	2	2	0.0	15	0	0.7
Eurytemora C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	62	19	1.4	26	3	0.7	16	10	0.3	89	43	1.5	15	0	0.7
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	4	4	0.1	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	4	4	0.1	0	0	0.0
Cladocerans															
Bosmina	0	0	0.0	14	9	0.4	33	27	0.6	4	4	0.1	13	4	0.6
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	0	0	0.0	5	5	0.1	5	1	0.1	0	0	0.0	2	1	0.1
Daphnia	0	0	0.0	0	0	0.0	5	1	0.1	4	4	0.1	15	8	0.7
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	0	0	0.0	0	0	0.0	2	2	0.0	0	0	0.0	7	3	0.3
Holopedium	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.0
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	0	0	0.0	0	0	0.0	2	2	0.0	0	0	0.0	2	1	0.1
Total	4391	401		3612	229		5535	488		5865	116		2262	127	
Dry wt (mg/m^3)	30	-		-	-		-	-		28	0.6		-	-	
Dry wt (µg/individual)	4.4	-		-	-		-	-		6	0.7		-	-	

TABLE 20 continued. 20 April 1974.

Genus	DC-1			DC-3			DC-4			NDC.5-2			NDC 1-1		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	738	57	62.3	1317	15	32.2	1098	19	23.2	1600	36	53.6	678	59	56.6
Cyclopoid copepods															
Cyclops C1-C5	181	8	15.3	460	5	11.3	474	34	10.0	537	9	18.0	252	24	21.0
Cyclops C6	82	15	6.9	945	133	23.1	1647	130	34.8	155	62	5.2	81	18	6.7
Tropocyclops	16	2	1.3	19	2	0.5	28	5	0.6	13	2	0.4	22	2	1.9
Calanoid copepods															
Diaptomus C1-C5	85	10	7.2	217	19	5.3	147	12	3.1	263	16	8.8	79	1	6.6
Diaptomus C6	41	14	3.4	981	181	24.0	1264	45	26.7	325	56	10.9	52	13	4.3
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	3	0	0.3	7	7	0.2	3	3	0.1	31	25	1.1	2	2	0.2
Eurytemora C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	1	1	0.1	66	9	1.6	48	19	1.0	14	13	0.4	0	0	0.0
Limnocalanus C6	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina	21	4	1.8	43	7	1.1	11	12	0.2	15	4	0.5	24	7	2.0
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	3	3	0.2	8	2	0.2	0	0	0.0	3	3	0.1	1	1	0.1
Daphnia	9	3	0.8	17	7	0.4	8	8	0.2	21	4	0.7	6	1	0.5
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	4	2	0.3	4	1	0.1	1	1	0.0	7	5	0.3	2	2	0.2
Holopedium	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	1	1	0.1	0	0	0.0	0	0	0.0	3	3	0.1	1	1	0.1
Total	**1183**	**97**		**4087**	**310**		**4732**	**58**		**2988**	**115**		**1199**	**2**	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 21. Mean abundance, standard deviation of the mean, percentage composition, and dry weight for zooplankton collected at 14 stations on 15 May 1974. Two samples were counted at each station.

Species	DC-2			DC-5			DC-6			DC-3		
	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%
Copepod nauplii	1530	325	18.0	2462	21	23.2	1921	41	26.5	1424	225	12.7
Cyclopoid copepods												
Cyclops C1-C5	3762	220	44.2	5140	255	48.5	2033	207	28.0	5730	603	51.1
Cyclops bicuspidatus thomasi	133	46	1.6	391	123	3.7	679	50	9.4	197	66	1.8
Cyclops vernalis	4	4	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	15	15	0.2	4	4	0.0	25	3	0.3	42	1	0.4
Calanoid copepods												
Diaptomus C1-C5	2449	634	28.7	2096	244	19.8	2146	169	29.6	3378	26	30.1
Diaptomus ashlandi	0	0	0.0	203	69	1.9	259	42	3.6	41	-	0.4
Diaptomus minutus	50	0	0.6	95	41	0.9	77	11	1.1	0	-	0.0
Diaptomus oregonensis	0	0	0.0	31	11	0.3	30	1	0.4	8	-	0.1
Diaptomus sicilis	0	0	0.0	7	7	0.1	4	4	0.1	0	-	0.0
Epischura C1-C5	242	49	2.8	0	0	0.0	0	0	0.0	85	11	0.8
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	15	15	0.2	7	7	0.1	2	2	0.0	59	15	0.5
Eurytemora affinis	0	0	0.0	0	0	0.0	0	0	0.0	8	0	0.1
Limnocalanus C1-C5	0	0	0.0	63	9	0.6	39	1	0.5	90	24	0.8
Limnocalanus macrurus	0	0	0.0	0	0	0.0	2	2	0.0	0	0	0.0
Harpacticoid copepods												
Canthocamptus sp	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans												
Bosmina longirostris	263	42	3.1	67	47	0.6	19	10	0.3	73	15	0.6
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	4	4	0.0	0	0	0.0	0	0	0.0	4	4	0.0
Daphnia galeata mendotae	47	3	0.5	0	0	0.0	5	0	0.1	33	-	0.4
Daphnia retrocurva	0	0	0.0	0	0	0.0	0	0	0.0	0	-	0.0
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	4	4	0.0	0	0	0.0	2	2	0.0	4	4	0.0
Holopedium gibberum	0	0	0.0	7	7	0.1	2	2	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	0	0	0.0	4	4	0.0	0	0	0.0	0	0	0.0
Rotifers												
Asplanchna spp.	7	7	0.1	17	3	0.2	5	0	0.1	30	22	0.3
Total	**8523**	**1111**		**10603**	**787**		**7257**	**515**		**11219**	**991**	
Dry wt (mg/m³)	-	-		40	3.6		-	-		-	-	
Dry wt (µg/individual)	-	-		3	0.4		-	-		-	-	

TABLE 21 continued. 15 May 1974.

Genus	DC-1			DC-4			NDC.5-1			NDC.5-2			NDC 7-1		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	614	208	19.2	2860	925	16.8	779	196	20.9	1764	570	19.5	1395	484	22.0
Cyclopoid copepods															
Cyclops C1-C5	1515	352	47.3	8880	2367	52.2	1566	78	42.1	3931	2076	43.4	2682	349	42.3
Cyclops C6	48	23	1.5	362	245	2.1	47	5	1.3	51	30	0.6	57	8	0.9
Tropocyclops	23	8	0.7	43	7	0.3	43	22	1.2	36	36	0.4	44	11	0.7
Calanoid copepods															
Diaptomus C1-C5	465	44	14.5	4154	301	24.4	613	2	16.5	2316	951	25.6	1517	413	23.9
Diaptomus C6	18	2	0.6	231	109	1.4	2	2	0.0	48	43	0.5	23	16	0.4
Epischura C1-C5	58	2	1.8	32	14	0.2	73	17	2.0	574	318	6.3	162	52	2.6
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	14	9	0.4	50	9	0.3	2	2	0.1	0	0	0.0	17	3	0.3
Eurytemora C6	0	0	0.0	7	7	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	144	53	0.9	4	3	0.1	5	5	0.1	6	7	0.1
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	2	2	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina	363	58	11.3	155	12	0.9	504	184	13.5	250	85	2.8	360	15	5.7
Ceriodaphnia	0	0	0.0	0	0	0.0	5	5	0.1	0	0	0.0	0	0	0.0
Chydorus	42	3	1.3	0	0	0.0	52	11	1.4	41	30	0.5	13	0	0.2
Daphnia	0	0	0.0	38	6	0.2	2	2	0.1	8	2	0.1	10	4	0.2
Diaphanosoma	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	5	5	0.2	7	2	0.0	0	0	0.0	0	0	0.0	3	3	0.0
Holopedium	0	0	0.0	9	5	0.1	0	0	0.0	0	0	0.0	3	3	0.1
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	3	3	0.1
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	3	3	0.0	0	0	0.0
Rotifers															
Asplanchna	37	27	1.2	29	2	0.2	30	2	0.8	29	9	0.3	40	19	0.6
Total	3203	301		17004	3705		3721	93		9054	4135		6337	1346	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (μg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 21 continued. 15 May 1974.

Genus	NDC 7-5			SDC.5-1			SDC.5-2			SDC 7-1			SDC 7-5		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	1386	130	16.8	790	154	24.9	1220	311	24.0	2891	477	22.8	4072	240	20.4
Cyclopoid copepods															
Cyclops C1-C5	4516	150	54.8	1370	78	43.2	1932	710	38.1	6618	3249	52.2	11515	730	57.6
Cyclops C6	162	24	2.0	18	11	0.6	12	7	0.2	158	135	1.3	161	7	0.8
Tropocyclops	22	5	0.3	11	4	0.3	10	0	0.2	44	7	0.3	25	9	0.1
Calanoid copepods															
Diaptomus C1-C5	1670	41	20.3	567	21	17.9	1284	381	25.3	2226	392	17.5	3780	195	18.9
Diaptomus C6	281	19	3.4	0	0	0.0	7	2	0.1	16	11	0.1	166	7	0.8
Epischura C1-C5	0	0	0.0	110	21	3.5	337	247	6.6	53	17	0.4	31	15	0.2
Epischura C6	0	0	0.0	0	0	0.0	0	0	0.0	5	5	0.0	0	0	0.0
Eurytemora C1-C5	29	12	0.4	0	0	0.0	3	3	0.1	23	23	0.2	28	5	0.1
Eurytemora C6	0	0	0.0	4	4	0.1	0	0	0.0	9	9	0.1	0	0	0.0
Limnocalanus C1-C5	82	2	1.0	4	4	0.1	5	5	0.1	2	2	0.0	97	12	0.5
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	4	4	0.1	0	0	0.0	9	0	0.1	0	0	0.0
Cladocerans															
Bosmina	65	20	0.8	215	60	6.8	203	113	4.0	497	207	3.9	77	11	0.4
Ceriodaphnia	0	0	0.0	4	4	0.1	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	0	0	0.0	29	0	0.9	32	4	0.6	120	54	0.9	0	0	0.0
Daphnia	17	3	0.2	4	4	0.1	0	0	0.0	5	5	0.0	20	1	0.1
Diaphanosoma	2	2	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina	2	2	0.0	4	4	0.1	5	5	0.1	0	0	0.0	4	4	0.0
Holopedium	9	2	0.1	0	0	0.0	0	0	0.0	0	0	0.0	14	3	0.1
Leptodora	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	5	5	0.1	40	3	1.3	23	15	0.5	9	9	0.1	10	2	0.1
Total	8246	74		3173	203		5074	1788		12686	4532		20000	1238	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		92	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		3	-	

TABLE 22. Mean abundance, standard deviation of the mean, percentage composition, and dry weight for zooplankton collected at 14 stations on 13 June 1974. Two samples were counted at each station.

Species	DC-1			DC-2			DC-3			DC-4			DC-5		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	298	28	6.0	386	25	1.9	887	6	7.8	1754	253	6.8	2510	309	8.6
Cyclopoid copepods															
Cyclops C1-C5	458	65	9.2	8464	1896	41.1	5151	816	45.3	12627	271	48.8	13693	998	46.6
Cyclops bicuspidatus thomasi	0	0	0.0	704	53	3.4	460	58	4.0	2007	401	7.8	2732	370	9.3
Cyclops vernalis	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	1	1	0.0	20	8	0.1	40	15	0.4	127	4	0.5	48	19	0.2
Calanoid copepods															
Diaptomus C1-C5	155	45	3.1	2631	112	12.8	1330	42	11.7	4760	493	18.4	7359	1159	25.1
Diaptomus ashlandi	14	3	0.3	86	13	0.4	126	9	1.1	650	92	2.5	1244	77	4.2
Diaptomus minutus	6	6	0.1	188	67	0.9	53	36	0.5	92	13	0.4	382	115	1.3
Diaptomus oregonensis	1	1	0.0	20	8	0.1	4	4	0.0	59	20	0.2	111	30	0.4
Diaptomus sicilis	0	0	0.0	0	0	0.0	0	0	0.0	7	2	0.0	29	16	0.1
Epischura C1-C5	17	8	0.3	112	16	0.5	6	0	0.0	15	15	0.1	0	0	0.0
Epischura lacustris	0	0	0.0	6	6	0.0	7	7	0.1	4	4	0.0	7	7	0.0
Eurytemora C1-C5	146	23	2.9	110	74	0.5	112	23	1.0	35	18	0.1	26	26	0.1
Eurytemora affinis	1	1	0.0	0	0	0.0	44	5	0.4	9	0	0.0	4	4	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	26	26	0.1
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	4	4	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	3096	433	62.3	7684	2223	37.3	2995	875	26.3	3630	157	14.0	1121	155	3.8
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	17	8	0.3	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	0	0	0.0	0	0	0.0	1	1	0.0	46	15	0.2	0	0	0.0
Daphnia retrocurva	0	0	0.0	19	5	0.1	18	1	0.2	31	13	0.1	41	26	0.1
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	13	13	0.3	53	17	0.3	11	6	0.1	17	9	0.1	0	0	0.0
Holopedium gibberum	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	7	2	0.1	7	7	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna spp.	737	190	14.8	126	30	0.6	129	29	1.1	11	11	0.0	14	1	0.0
Total	4969	665		20617	4208		11382	94		25883	148		29350	3006	
Dry wt (mg/m^3)	-	-		-	-		25	9.2		61	8.4		-	-	
Dry wt (μg/individual)	-	-		-	-		2	0.6		2	0.1		-	-	

TABLE 22 continued. 13 June 1974.

Species	DC-6 #/m³	DC-6 SX̄	DC-6 %	NDC.5-1 #/m³	NDC.5-1 SX̄	NDC.5-1 %	NDC.5-2 #/m³	NDC.5-2 SX̄	NDC.5-2 %	NDC 7-1 #/m³	NDC 7-1 SX̄	NDC 7-1 %	NDC 7-5 #/m³	NDC 7-5 SX̄	NDC 7-5 %
Copepod nauplii	4472	189	13.5	285	69	6.6	553	98	6.5	377	7	5.3	1732	573	7.1
Cyclopoid copepods															
Cyclops C1-C5	13807	358	41.8	590	80	13.6	3685	1015	43.2	2772	849	39.3	13778	183	56.3
Cyclops bicuspidatus thomasi	2710	107	8.2	0	0	0.0	76	72	0.9	47	29	0.7	1899	570	7.8
Cyclops vernalis	4	4	0.0	0	0	0.0	0	0	0.0	0	0	0.0	4	4	0.0
Tropocyclops prasinus mexicanus	8	8	0.0	8	8	0.2	8	3	0.1	9	9	0.1	71	40	0.3
Calanoid copepods															
Diaptomus C1-C5	10291	647	31.2	126	4	2.9	406	72	4.8	383	72	5.4	4867	346	19.9
Diaptomus ashlandi	964	239	2.9	11	0	0.3	64	21	0.8	49	6	0.7	521	233	2.1
Diaptomus minutus	82	82	0.3	60	6	1.4	35	11	0.4	13	13	0.2	295	104	1.2
Diaptomus oregonensis	0	0	0.0	0	0	0.0	6	6	0.1	5	5	0.1	34	12	0.1
Diaptomus sicilis	25	25	0.1	0	0	0.0	0	0	0.0	0	0	0.0	30	15	0.1
Epischura C1-C5	0	0	0.0	33	17	0.8	9	9	0.1	23	23	0.3	0	0	0.0
Epischura lacustris	0	0	0.0	3	3	0.1	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	0	0	0.0	91	37	2.1	61	18	0.7	124	23	1.8	19	4	0.1
Eurytemora affinis	0	0	0.0	0	0	0.0	5	5	0.1	0	0	0.0	19	4	0.1
Limnocalanus C1-C5	86	78	0.3	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	107	11	0.3	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	366	136	1.1	2794	818	64.4	3271	1224	38.4	2535	8	35.9	1153	132	4.7
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	0	0	0.0	11	6	0.3	33	10	0.4	23	14	0.3	0	0	0.0
Daphnia galeata mendotae	12	12	0.0	0	0	0.0	0	0	0.0	0	0	0.0	19	4	0.1
Daphnia retrocurva	4	4	0.0	0	0	0.0	0	0	0.0	4	4	0.1	4	4	0.0
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	5	0	0.1	2	2	0.0	0	0	0.0	0	0	0.0
Holopedium gibberum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	0	0	0.0	8	3	0.2	2	2	0.0	5	5	0.1	0	0	0.0
Rotifers															
Asplanchna spp.	78	78	0.2	317	51	7.3	304	94	3.6	691	50	9.8	11	11	0.0
Total	33025	395		4341	806		8522	2426		7058	934		24455	122	
Dry wt (mg/m^3)	160	24		-	-		36	-		24	-		123	40.1	
Dry wt (μg/individual)	4	0.6		-	-		3	-		3	-		4	1.4	

TABLE 22 continued. 13 June 1974.

Species	SDC.5-1			SDC.5-2			SDC 7-1			SDC 7-5		
	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%
Copepod nauplii	493	138	9.5	739	113	6.2	847	5	10.8	2371	102	6.9
Cyclopoid copepods												
Cyclops C1-C5	809	206	15.6	6070	839	51.2	1608	233	20.6	15482	2	44.8
Cyclops bicuspidatus thomasi	33	25	0.6	224	35	1.9	121	62	1.5	4561	814	13.2
Cyclops vernalis	0	0	0.0	0	0	0.0	0	0	0.0	18	18	0.1
Tropocyclops prasinus mexicanus	4	4	0.1	58	28	0.5	0	0	0.0	21	21	0.1
Calanoid copepods												
Diaptomus C1-C5	154	14	3.0	1237	167	10.4	205	19	2.6	8207	1110	23.8
Diaptomus ashlandi	7	7	0.1	45	24	0.4	10	10	0.1	1882	215	5.5
Diaptomus minutus	11	3	0.2	43	43	0.4	40	16	0.5	48	12	0.1
Diaptomus oregonensis	0	0	0.0	0	0	0.0	0	0	0.0	205	153	0.6
Diaptomus sicilis	0	0	0.0	0	0	0.0	0	0	0.0	13	5	0.0
Epischura C1-C5	17	17	0.3	47	7	0.4	0	0	0.0	13	13	0.0
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	36	36	0.7	123	15	1.0	169	42	2.2	18	0	0.1
Eurytemora affinis	0	0	0.0	5	5	0.0	0	0	0.0	9	9	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	13	5	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	9	9	0.0
Harpacticoid copepods												
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans												
Bosmina longirostris	2880	354	55.7	3007	253	25.4	3762	1010	48.1	1564	103	4.5
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	17	12	0.3	10	0	0.1	62	6	0.8	0	0	0.0
Daphnia galeata mendotae	4	4	0.1	10	10	0.1	0	0	0.0	18	0	0.1
Daphnia retrocurva	0	0	0.0	11	11	0.1	0	0	0.0	22	4	0.1
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	11	11	0.1	14	14	0.2	0	0	0.0
Holopedium gibberum	0	0	0.0	0	0	0.0	0	0	0.0	9	9	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	11	3	0.2	5	5	0.0	45	11	0.6	0	0	0.0
Rotifers												
Asplanchna spp.	696	113	13.5	206	12	1.7	930	333	11.9	76	50	0.2
Total	5173	669		11857	1217		7816	1251		34557	2549	
Dry wt (mg/m³)	-	-		21	-		16	6.5		141	-	
Dry wt (μg/individual)	-	-		1	0.2		1	0.7		3	-	

TABLE 23. Mean abundance, standard deviation of the mean, percentage composition, and dry weight of zooplankton collected at 30 stations on 11 July 1974. Two samples were counted at each station.

Species	DC-1			DC-2			DC-3			DC-4			DC-5		
	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%
Copepod nauplii	2136	358	6.3	1385	262	3.7	892	402	2.4	3435	83	3.6	465	126	0.3
Cyclopoid copepods															
Cyclops C1-C5	9444	305	28.0	7807	1344	20.7	9169	584	24.3	23871	5021	24.7	29855	7483	18.1
Cyclops bicuspidatus thomasi	1700	16	5.0	1689	33	4.5	1964	33	5.2	8981	2012	9.3	7273	1850	4.4
Cyclops vernalis	0	0	0.0	101	73	0.3	0	0	0.0	17	17	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	0	0	0.0	12	12	0.0	0	0	0.0	67	67	0.1	42	42	0.0
Calanoid copepods															
Diaptomus C1-C5	2830	85	8.4	3793	1372	10.0	5982	559	15.8	16426	3483	17.0	8923	2228	5.4
Diaptomus ashlandi	2629	459	7.8	3248	429	8.6	4467	194	11.8	8045	1541	8.3	2453	419	1.5
Diaptomus minutus	0	0	0.0	39	11	0.1	0	0	0.0	452	452	0.5	381	212	0.2
Diaptomus oregonensis	0	0	0.0	0	0	0.0	100	2	0.3	235	235	0.2	42	42	0.0
Diaptomus sicilis	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	127	127	0.1
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura lacustris	0	0	0.0	0	0	0.0	10	10	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	863	166	2.6	276	23	0.7	360	31	1.0	201	201	0.2	42	42	0.0
Eurytemora affinis	0	0	0.0	6	6	0.0	70	12	0.2	67	67	0.1	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	67	67	0.1	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	50	50	0.1	42	42	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	13924	1137	41.2	19188	549	50.8	14547	1238	38.5	34239	4372	35.5	114384	3374	69.4
Ceriodaphnia quadrangula	0	0	0.0	14	14	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	16	16	0.1	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	0	0	0.0	0	0	0.0	0	0	0.0	17	17	0.0	84	84	0.0
Daphnia retrocurva	0	0	0.0	12	12	0.0	30	11	0.1	201	101	0.2	635	43	0.4
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	0	0	0.0	29	29	0.1	33	0	0.0	0	0	0.0
Holopedium gibberum	0	0	0.0	0	0	0.0	0	0	0.0	17	17	0.0	42	42	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	8	8	0.0	14	14	0.0	0	0	0.0	0	0	0.0	85	0	0.1
Rotifers															
Asplanchna spp.	198	52	0.6	189	48	0.5	160	4	0.4	84	50	0.1	0	0	0.0
Total	33762	1201		37773	2143		37782	2228		96504	17653		164875	15224	
Dry wt (mg/m^3)	-	-		-	-		-	-		329	49.9		-	-	
Dry wt (μg/individual)	-	-		-	-		-	-		3	0.6		-	-	

TABLE 23 continued. 11 July 1974.

Species	DC-6			NDC.5-1			NDC.5-2			NDC 1-1			NDC 1-2		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	180	76	0.3	3058	591	10.2	3591	27	7.5	2333	122	13.3	2629	1209	8.1
Cyclopoid copepods															
Cyclops C1-C5	10852	785	20.4	8501	116	28.5	9864	1364	20.6	5477	228	31.3	8567	76	26.5
Cyclops bicuspidatus thomasi	4364	265	8.2	1636	539	5.5	2164	539	4.5	1032	315	5.9	1987	233	6.1
Cyclops vernalis	0	0	0.0	26	26	0.1	298	152	0.6	67	49	0.4	7	7	0.0
Tropocyclops prasinus mexicanus	19	6	0.0	0	0	0.0	10	10	0.0	0	0	0.0	0	0	0.0
Calanoid copepods															
Diaptomus C1-C5	4379	767	8.2	2963	300	9.9	4554	520	9.5	1765	45	10.1	3328	12	10.3
Diaptomus ashlandi	715	229	1.3	3048	952	10.2	5044	2067	10.5	1161	176	6.6	2335	142	7.2
Diaptomus minutus	535	254	1.0	5	5	0.0	10	10	0.0	0	0	0.0	7	7	0.0
Diaptomus oregonensis	58	20	0.1	5	5	0.0	29	29	0.1	20	11	0.1	33	33	0.1
Diaptomus sicilis	32	32	0.1	9	9	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura lacustris	19	19	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	13	13	0.0	592	171	2.0	548	97	1.1	495	168	2.8	393	80	1.2
Eurytemora affinis	6	6	0.0	0	0	0.0	0	0	0.0	0	0	0.0	14	14	0.0
Limnocalanus C1-C5	13	13	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	31737	589	59.7	9716	1330	32.5	21623	1329	45.2	4952	531	28.3	12678	1292	39.2
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	0	0	0.0	15	15	0.0	0	0	0.0	21	21	0.1	14	14	0.0
Daphnia galeata mendotae	39	13	0.1	0	0	0.0	10	10	0.0	5	5	0.0	14	14	0.0
Daphnia retrocurva	154	25	0.3	0	0	0.0	0	0	0.0	0	0	0.0	14	14	0.0
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	13	13	0.0
Holopedium gibberum	6	6	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	58	32	0.1	0	0	0.0	0	0	0.0	31	22	0.2	14	14	0.0
Rotifers															
Asplanchna spp.	0	0	0.0	289	44	0.1	91	7	0.2	149	75	0.9	284	23	0.9
Total	53181	2770		29864	821		47835	3086		17508	24		32330	2543	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 23 continued. 11 July 1974.

Species	NDC 2-1			NDC 2-3			NDC 4-1			NDC 4-3			NDC 4-4		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	2020	473	10.7	991	123	4.4	2464	877	8.4	1123	811	2.2	1018	72	1.9
Cyclopoid copepods															
Cyclops C1-C5	6908	153	36.7	8136	1555	35.8	12368	522	42.1	14589	1019	28.8	20538	4710	38.1
Cyclops bicuspidatus thomasi	2488	136	13.2	2766	693	12.2	4300	202	14.6	3027	342	6.0	6420	1057	11.9
Cyclops vernalis	183	183	1.0	78	39	0.3	49	49	0.2	44	28	0.1	0	0	0.0
Tropocyclops prasinus mexicanus	0	0	0.0	3	3	0.0	0	0	0.0	44	28	0.1	82	39	0.2
Calanoid copepods															
Diaptomus C1-C5	1758	56	9.3	2397	39	10.5	3026	51	10.3	3978	190	7.9	6370	1399	11.8
Diatomus ashlandi	1214	113	6.5	2753	849	12.1	3104	410	10.6	1443	292	2.9	1770	658	3.3
Diaptomus minutus	39	39	0.2	13	13	0.1	21	21	0.1	17	17	0.0	702	245	1.3
Diaptomus oregonensis	0	0	0.0	71	32	0.3	73	73	0.3	25	25	0.0	172	2	0.3
Diaptomus sicilis	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	11	11	0.0
Epischura C1-C5	0	0	0.0	6	6	0.0	0	0	0.0	0	0	0.0	12	12	0.0
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	246	116	1.3	52	0	0.2	149	19	0.5	61	11	0.1	12	12	0.0
Eurytemora affinis	2	2	0.0	0	0	0.0	7	7	0.0	0	0	0.0	81	16	0.2
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	81	16	0.2
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	69	4	0.1
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	3783	1367	20.1	5377	428	23.7	3521	606	12.0	26010	4673	51.4	16008	2054	29.7
Ceriodaphnia quadrangula	2	2	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	17	1	0.1	0	0	0.0	113	1	0.4	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	0	0	0.0	23	23	0.1	0	0	0.0	20	4	0.0	107	63	0.2
Daphnia retrocurva	0	0	0.0	19	7	0.1	0	0	0.0	66	18	0.1	349	88	0.7
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	7	7	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	0	0	0.0	0	0	0.0	24	24	0.0	61	61	0.1
Holopedium gibberum	0	0	0.0	0	0	0.0	0	0	0.0	8	8	0.0	0	0	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	12	12	0.0
Polyphemus pediculus	0	0	0.0	16	10	0.1	7	7	0.0	8	8	0.0	47	26	0.1
Rotifers															
Asplanchna spp.	158	85	0.8	32	32	0.1	146	48	0.5	90	6	0.2	22	22	0.0
Total	18822	1810		22737	3368		29392	194		50577	7303		53946	10364	
Dry wt (mg/m^3)	-	-		85	11.5		108	5.7		-	-		-	-	
Dry wt (μg/individual)	-	-		3	0.6		3	0.3		-	-		-	-	

TABLE 23 continued. 11 July 1974.

Species	NDC 7-1			NDC 7-3			NDC 7-5			SDC.5-1			SDC.5-2		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	340	44	2.1	980	69	1.6	388	116	0.8	1242	316	10.4	1317	711	10.9
Cyclopoid copepods															
Cyclops C1-C5	1330	59	8.4	11100	1136	18.6	16791	843	34.2	3408	490	28.4	2733	645	22.7
Cyclops bicuspidatus thomasi	107	4	0.7	2121	118	3.6	4261	734	8.7	448	184	3.7	63	7	0.5
Cyclops vernalis	0	0	0.0	0	0	0.0	23	23	0.0	2	2	0.0	3	3	0.0
Tropocyclops prasinus mexicanus	18	4	0.1	55	56	0.1	23	23	0.0	2	2	0.0	2	2	0.0
Calanoid copepods															
Diaptomus C1-C5	565	11	3.6	3627	379	6.1	7101	48	14.5	1844	196	15.4	1116	151	9.3
Diaptomus ashlandi	255	63	1.6	1590	158	2.7	2549	74	5.2	1383	379	11.5	338	41	2.8
Diaptomus minutus	0	0	0.0	54	17	0.1	319	2	0.7	93	93	0.8	0	0	0.0
Diaptomus oregonensis	7	7	0.1	117	44	0.2	0	0	0.0	6	6	0.1	2	2	0.0
Diaptomus sicilis	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Epischura C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	2	2	0.0	0	0	0.0
Epischura lacustris	0	0	0.0	18	18	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	196	11	1.2	147	36	0.2	0	0	0.0	382	226	3.2	115	66	1.0
Eurytemora affinis	4	4	0.0	15	15	0.0	34	11	0.1	0	0	0.0	2	2	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	12292	296	77.5	38979	495	65.4	16949	1092	34.5	2999	851	25.0	6143	703	50.9
Ceriodaphnia quadrangula	4	4	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	7	7	0.1	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	0	0	0.0	33	3	0.1	193	124	0.4	0	0	0.0	1	1	0.0
Daphnia retrocurva	7	0	0.0	167	15	0.3	216	101	0.4	8	8	0.1	2	2	0.0
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	7	7	0.1	55	55	0.1	170	101	0.4	5	5	0.0	0	0	0.0
Holopedium gibberum	0	0	0.0	5	5	0.0	57	12	0.1	2	2	0.0	1	1	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	26	11	0.2	59	22	0.1	11	11	0.0	30	3	0.3	25	2	0.2
Rotifers															
Asplanchna spp.	694	0	4.4	515	31	0.9	0	0	0.0	129	45	1.1	199	100	1.7
Total	15860	251		59636	1979		49083	1421		11982	2800		12065	1049	
Dry wt (mg/m^3)	-	-		263	65		149	56.1		-	-		-	-	
Dry wt (μg/individual)	-	-		4	0.8		3	1.3		-	-		-	-	

TABLE 23 continued. 11 July 1974.

Species	SDC 1-1			SDC 1-2			SDC 2-1			SDC 2-3			SDC 4-1		
	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%
Copepod nauplii	1851	708	8.8	1665	124	5.5	331	130	8.0	3256	754	5.8	72	22	6.7
Cyclopoid copepods															
Cyclops C1-C5	3039	1009	14.4	9148	898	30.3	999	805	24.1	19550	3227	34.7	121	60	11.2
Cyclops bicuspidatus thomasi	195	64	0.9	1140	141	3.8	210	192	5.1	4211	1323	7.5	7	6	0.7
Cyclops vernalis	8	8	0.0	0	0	0.0	0	0	0.0	2028	243	3.6	1	1	0.1
Tropocyclops prasinus mexicanus	0	0	0.0	15	0	0.0	2	1	0.0	29	29	0.1	0	0	0.0
Calanoid copepods															
Diaptomus C1-C5	1958	763	9.3	2351	153	7.8	427	291	10.3	5823	1396	10.3	180	33	16.6
Diaptomus ashlandi	924	307	4.4	1299	-	4.3	166	152	4.0	3864	1670	6.9	33	10	3.0
Diaptomus minutus	0	0	0.0	100	-	0.3	5	1	0.1	0	0	0.0	8	2	0.7
Diaptomus oregonensis	32	32	0.2	29	-	0.1	6	6	0.1	30	30	0.1	0	0	0.0
Diaptomus sicilis	0	0	0.0	0	-	0.0	0	0	0.0	40	40	0.1	0	0	0.0
Epischura C1-C5	0	0	0.0	0	0	0.0	2	1	0.0	0	0	0.0	0	0	0.0
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eurytemora C1-C5	426	125	2.0	320	37	1.1	215	29	5.2	130	111	0.2	192	92	17.8
Eurytemora affinis	0	0	0.0	7	7	0.0	1	1	0.0	49	11	0.1	1	1	0.1
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	12544	6371	59.4	13857	2866	45.9	1646	684	39.8	17140	1627	30.4	441	290	40.8
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.1
Daphnia galeata mendotae	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.1
Daphnia retrocurva	0	0	0.0	0	0	0.0	4	4	0.1	29	29	0.1	1	1	0.1
Diaphanosoma leuchtenbergianum	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Holopedium gibberum	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	0.1
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	13	13	0.1	36	21	0.1	38	2	0.9	30	30	0.1	18	4	1.7
Rotifers															
Asplanchna spp.	132	30	0.6	233	24	0.8	88	29	2.1	197	24	0.3	4	3	0.3
Total	21122	9404		30558	4438		4140	2321		56405	9940		1080	521	
Dry wt (mg/m³)	-	-		148	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		3	-		-	-		-	-		-	-	

TABLE 23 continued. 11 July 1974.

Species	SDC 4-3			SDC 4-4			SDC 7-1			SDC 7-3			SDC 7-5		
	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%
Copepod nauplii	2711	104	4.6	461	36	0.9	140	38	2.3	1313	320	3.2	943	116	1.0
Cyclopoid copepods															
Cyclops C1-C5	12838	97	21.6	12351	1868	24.1	599	373	9.9	13938	3578	33.8	22689	6593	24.2
Cyclops bicuspidatus thomasi	7199	1663	12.1	4183	846	8.2	80	63	1.3	3518	949	8.5	7658	2557	8.2
Cyclops vernalis	7	7	0.0	0	0	0.0	2	2	0.0	27	27	0.1	0	0	0.0
Tropocyclops prasinus mexicanus	7	7	0.0	16	0	0.0	1	1	0.0	26	9	0.1	0	0	0.0
Calanoid copepods															
Diaptomus C1-C5	10511	2603	17.6	4452	391	8.7	475	193	8.0	5418	1709	13.2	6071	2101	6.5
Diaptomus ashlandi	3770	477	6.3	936	197	1.8	94	61	1.6	4752	1843	11.5	2660	228	2.8
Diaptomus minutus	169	139	0.3	365	287	0.7	26	26	0.4	230	230	0.6	365	365	0.4
Diaptomus oregonensis	117	88	0.2	132	54	0.3	1	1	0.0	115	115	0.3	352	280	0.4
Diaptomus sicilis	37	37	0.1	16	16	0.0	0	0	0.0	9	9	0.0	73	73	0.1
Epischura C1-C5	44	44	0.1	210	210	0.4	2	2	0.0	0	0	0.0	0	0	0.0
Epischura lacustris	0	0	0.0	23	8	0.0	0	0	0.0	9	9	0.0	0	0	0.0
Eurytemora C1-C5	265	145	0.4	94	31	0.2	224	43	3.7	195	178	0.5	97	49	0.1
Eurytemora affinis	37	37	0.1	16	15	0.0	10	3	0.2	9	9	0.0	72	72	0.1
Limnocalanus C1-C5	0	0	0.0	23	23	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	23	8	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	21360	10259	35.9	27436	3920	53.5	4212	2153	70.0	11394	225	27.7	52159	19052	55.7
Ceriodaphnia quadrangula	7	7	0.0	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	30	30	0.1	24	24	0.0	0	0	0.0	18	18	0.0	0	0	0.0
Daphnia retrocurva	149	61	0.3	311	170	0.6	3	3	0.1	97	63	0.2	400	135	0.4
Diaphanosoma leuchtenbergianum	0	0	0.0	8	8	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Eubosmina coregoni	22	22	0.0	23	23	0.0	0	0	0.0	9	9	0.0	0	0	0.0
Holopedium gibberum	45	45	0.1	54	39	0.1	0	0	0.0	9	9	0.0	36	36	0.0
Leptodora kindtii	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Polyphemus pediculus	15	15	0.0	86	54	0.2	16	0	0.3	35	18	0.1	12	12	0.0
Rotifers															
Asplanchna spp.	244	64	0.4	0	0	0.0	133	118	2.2	68	68	0.2	0	0	0.0
Total	59584	13803		51243	8131		6019	3078		41188	8168		93586	30741	
Dry wt (mg/m³)	-	-		84	22.1		-	-		-	-		56	22.0	
Dry wt (µg/individual)	-	-		2	0.4		-	-		-	-		1	0.4	

TABLE 24. Mean abundance, standard deviation of the mean, percentage composition, and dry weight for zooplankton collected at 14 stations on 22 August 1974. Two samples were counted at each station.

Species	DC-1			DC-2			DC-3			DC-4			DC-5		
	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%
Copepod nauplii	4689	587	44.8	4373	111	19.5	2812	1567	9.8	1472	337	7.3	3459	-	6.7
Cyclopoid copepods															
Cyclops C1-C5	181	97	1.7	1703	137	7.6	9209	2033	32.2	4904	897	24.1	10318	-	20.0
Cyclops bicuspidatus thomasi	2	1	0.0	183	66	0.8	1447	658	5.1	1006	350	5.0	2610	-	5.1
Cyclops vernalis	0	0	0.0	0	0	0.0	22	22	0.1	55	55	0.3	0	-	0.0
Tropocyclops prasinus mexicanus	34	3	0.3	847	173	3.8	388	160	1.4	521	352	2.6	182	-	0.4
Calanoid copepods															
Diaptomus C1-C5	946	441	9.0	2210	20	9.8	3481	393	12.2	4161	455	20.5	15052	-	29.1
Diaptomus ashlandi	0	0	0.0	70	25	0.3	1167	412	4.1	418	143	2.1	2003	-	3.9
Diaptomus minutus	44	17	0.4	260	1	1.2	131	17	0.5	238	105	1.2	1335	-	2.6
Diaptomus oregonensis	3	3	0.0	42	29	0.2	91	56	0.3	8	8	0.0	61	-	0.1
Diaptomus sicilis	0	0	0.0	0	0	0.0	11	11	0.0	8	8	0.0	30	-	0.1
Epischura C1-C5	65	65	0.6	895	196	4.0	1354	1214	4.7	490	446	2.4	182	-	0.4
Epischura lacustris	0	0	0.0	6	6	0.0	11	11	0.0	0	0	0.0	0	-	0.0
Eurytemora C1-C5	552	191	5.3	2363	86	10.5	1442	495	5.0	306	84	1.5	61	-	0.1
Eurytemora affinis	5	2	0.0	68	3	0.3	144	109	0.5	55	55	0.3	0	-	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	4	4	0.0	23	23	0.1	0	-	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	8	8	0.0	0	-	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	-	0.0
Cladocerans															
Bosmina longirostris	2020	877	19.3	5493	414	24.5	3442	1653	12.0	3201	666	15.8	6555	-	12.7
Ceriodaphnia quadrangula	103	70	1.0	259	85	1.2	72	54	0.3	454	29	2.2	1184	-	2.3
Chydorus sphaericus	3	3	0.0	0	0	0.0	54	10	0.2	8	8	0.0	0	-	0.0
Daphnia galeata mendotae	9	9	0.1	71	-	0.3	18	17	0.1	70	54	0.3	121	-	0.2
Daphnia retrocurva	365	260	3.5	1140	-	5.2	2195	879	7.7	1434	406	7.1	5644	-	10.9
Diaphanosoma leuchtenbergianum	0	0	0.0	13	13	0.1	28	7	0.1	16	16	0.1	91	-	0.2
Eubosmina coregoni	17	4	0.2	422	53	1.9	291	151	1.0	539	7	2.7	2701	-	5.2
Holopedium gibberum	80	26	0.8	318	26	1.4	175	35	0.6	296	296	1.5	0	-	0.0
Leptodora kindtii	17	14	0.2	61	22	0.3	15	6	0.1	18	18	0.1	0	-	0.0
Polyphemus pediculus	66	21	0.6	174	20	0.8	49	14	0.2	113	43	0.6	61	-	0.1
Rotifers															
Asplanchna spp.	1260	400	12.0	1500	29	6.7	525	297	1.8	492	85	2.4	30	-	0.1
Total	10460	2927		22428	890		28587	10192		20313	4810		51679	-	
Dry wt (mg/m³)	27	-		85	19.2		141	-		81	30.0		85	-	
Dry wt (µg/individual)	3	-		3	0.8		2	-		3	0.5		1	-	

TABLE 24 continued. 22 August 1974.

Species	DC-6			NDC.5-2			NDC 7-1		
	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%
Copepod nauplii	738	70	2.2	4412	339	28.4	4828	0	23.6
Cyclopoid copepods									
Cyclops C1-C5	6659	1382	20.0	1008	165	6.5	625	35	3.1
Cyclops bicuspidatus thomasi	1079	41	3.2	23	23	0.1	28	0	0.1
Cyclops vernalis	9	9	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	244	68	0.7	287	39	1.9	214	10	1.0
Calanoid copepods									
Diaptomus C1-C5	12945	1300	38.8	2650	289	17.1	1116	7	5.5
Diaptomus ashlandi	1823	380	5.5	0	0	0.0	28	-	0.1
Diaptomus minutus	537	78	1.6	40	5	0.3	42	-	0.2
Diaptomus oregonensis	167	167	0.5	8	7	0.1	0	-	0.0
Diaptomus sicilis	99	7	0.3	0	0	0.0	0	-	0.0
Epischura C1-C5	1883	1424	5.7	553	124	3.6	284	102	1.4
Epischura lacustris	0	0	0.0	0	0	0.0	4	3	0.0
Eurytemora C1-C5	62	26	0.2	831	41	5.4	435	140	2.1
Eurytemora affinis	0	0	0.0	25	10	0.2	0	0	0.0
Limnocalanus C1-C5	27	10	0.1	0	0	0.0	0	0	0.0
Limnocalanus macrurus	44	26	0.1	0	0	0.0	0	0	0.0
Harpacticoid copepods									
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans									
Bosmina longirostris	1196	352	3.6	2544	17	16.4	9979	716	48.8
Ceriodaphnia quadrangula	92	92	0.3	175	32	1.1	175	63	0.9
Chydorus sphaericus	18	18	0.1	43	17	0.3	0	0	0.0
Daphnia galeata mendotae	1187	466	3.6	33	10	0.2	32	3	0.2
Daphnia retrocurva	4112	954	12.3	1449	321	9.3	891	414	4.4
Diaphanosoma leuchtenbergianum	89	16	0.3	16	1	0.1	35	7	0.2
Eubosmina coregoni	202	202	0.6	288	73	1.9	56	14	0.3
Holopedium gibberum	97	97	0.3	146	26	0.9	53	18	0.3
Leptodora kindtii	45	10	0.1	24	6	0.2	14	14	0.1
Polyphemus pediculus	0	0	0.0	114	24	0.7	84	42	0.4
Rotifers									
Asplanchna spp.	0	0	0.0	857	15	5.5	1509	288	7.4
Total	33352	442		15524	48		20449	463	
Dry wt (mg/m³)	-	-		43	19.9		-	-	
Dry wt (μg/individual)	-	-		2	1.0		-	-	

TABLE 24 continued. 22 August 1974.

Genus	NDC.5-1			NDC 7-5			SDC 7-1		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	4100	336	34.6	1333	387	3.1	851	245	13.2
Cyclopoid copepods									
Cyclops C1-C5	395	32	3.3	6674	550	15.5	123	16	1.9
Cyclops C6	0	0	0.0	1217	159	2.8	35	15	0.6
Tropocyclops	89	32	0.8	326	76	0.7	302	120	4.7
Calanoid copepods									
Diaptomus C1-C5	1586	55	13.4	15826	3327	36.8	462	150	7.2
Diaptomus C6	35	16	0.3	3261	867	7.6	278	80	4.3
Epischura C1-C5	374	72	3.2	1634	1634	3.8	254	91	3.9
Epischura C6	0	0	0.0	14	14	0.0	0	0	0.0
Eurytemora C1-C5	504	58	4.2	57	57	0.1	714	32	11.1
Eurytemora C6	9	3	0.1	0	0	0.0	31	7	0.5
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods									
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans									
Bosmina	2256	100	19.0	4992	1429	11.6	2384	445	37.0
Ceriodaphnia	114	20	1.0	57	57	0.1	37	9	0.6
Chydorus	10	10	0.1	98	69	0.2	8	0	0.1
Daphnia	1196	297	10.1	5008	554	11.6	134	39	2.1
Diaphanosoma	27	5	0.2	43	43	0.1	2	2	0.0
Eubosmina	40	18	0.3	1351	627	3.1	168	89	2.6
Holopedium	105	10	0.9	923	338	2.1	100	1	1.6
Leptodora	28	3	0.2	14	14	0.0	0	0	0.0
Polyphemus	20	14	0.2	0	0	0.0	99	19	1.5
Rotifers									
Asplanchna	976	58	8.2	171	87	0.4	470	15	7.3
Total	11864	21		43000	3470		6452	331	
Dry wt (mg/m^3)	**51**	-		-	-		-	-	
Dry wt (μg/individual)	**3**	-		-	-		-	-	

TABLE 24 continued. 22 August 1974.

Species	SDC.5-1			SDC.5-2			SDC 7-5		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	2372	155	19.6	3103	375	19.1	2590	137	5.2
Cyclopoid copepods									
Cyclops C1-C5	262	29	2.2	378	25	2.3	8501	129	17.0
Cyclops bicuspidatus thomasi	38	11	0.3	58	5	0.4	2093	457	4.2
Cyclops vernalis	0	0	0.0	-	-	-	-	-	-
Tropocyclops prasinus mexicanus	454	58	3.7	902	160	5.5	788	194	1.6
Calanoid copepods									
Diaptomus C1-C5	676	19	5.6	1448	526	8.9	9354	655	18.7
Diaptomus ashlandi	6	-	0.1	0	-	0.0	529	-	1.1
Diaptomus minutus	43	-	0.4	226	-	1.4	305	-	0.6
Diaptomus oregonensis	0	-	0.0	0	-	0.0	0	-	0.0
Diaptomus sicilis	6	-	0.1	0	-	0.0	0	-	0.0
Epischura C1-C5	220	3	1.8	385	186	2.4	749	428	1.5
Epischura lacustris	0	0	0.0	7	2	0.0	0	0	0.0
Eurytemora C1-C5	1003	180	8.3	1182	204	7.3	277	181	0.6
Eurytemora affinis	18	5	0.2	40	31	0.2	57	41	0.1
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	8	8	0.0
Harpacticoid copepods									
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans									
Bosmina longirostris	5182	185	42.9	5885	200	36.2	17464	982	34.9
Ceriodaphnia quadrangula	252	95	2.1	338	123	2.1	800	146	1.6
Chydorus sphaericus	8	8	0.1	0	0	0.0	0	0	0.0
Daphnia galeata mendotae	0	-	0.0	36	-	0.2	160	-	0.3
Daphnia retrocurva	68	-	0.7	471	-	2.9	3048	-	6.1
Diaphanosoma leuchtenbergianum	2	2	0.0	20	7	0.1	73	57	0.1
Eubosmina coregoni	34	9	0.3	418	47	2.6	2641	171	5.3
Holopedium gibberum	122	122	1.0	121	121	0.7	474	474	1.0
Leptodora kindtii	24	7	0.2	29	2	0.2	8	8	0.0
Polyphemus pediculus	60	10	0.5	66	39	0.4	49	49	0.1
Rotifers									
Asplanchna spp.	1173	71	9.7	1153	223	7.1	106	58	0.2
Total	12076	732		16407	508		50883	854	
Dry wt (mg/m^3)	49	7.0		60	20.7		157	47.2	
Dry wt (µg/individual)	3	0.5		3	0.9		3	1.0	

TABLE 25. Mean abundance, standard deviation of the mean, percentage composition, and dry weight for zooplankton collected at 14 stations on 12 September 1974. Two samples were counted at each station.

Species	DC-1			DC-2			DC-3			DC-4			DC-5		
	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%	#/m³	$S\bar{x}$	%
Copepod nauplii	2375	287	12.3	1417	47	5.6	794	151	4.0	1039	258	2.9	1259	176	2.8
Cyclopoid copepods															
Cyclops C1-C5	949	29	4.9	6018	419	23.7	6148	180	30.8	14533	1246	40.7	14509	1972	31.7
Cyclops bicuspidatus thomasi	0	0	0.0	706	207	2.8	1292	71	6.5	3344	403	9.4	3655	315	8.0
Cyclops vernalis	0	0	0.0	0	0	0.0	0	0	0.0	135	135	0.4	183	183	0.4
Tropocyclops prasinus mexicanus	158	46	0.8	93	35	0.4	108	1	0.6	447	112	1.3	194	77	0.4
Calanoid copepods															
Diaptomus C1-C5	671	182	3.5	3625	1	14.3	3341	264	16.7	4798	1002	13.4	10335	1695	22.6
Diaptomus ashlandi	17	17	0.1	20	9	0.1	157	29	0.8	785	134	2.2	1459	346	3.2
Diaptomus minutus	764	214	4.0	163	94	0.6	254	67	1.3	244	188	0.7	340	99	0.7
Diaptomus oregonensis	0	0	0.0	146	53	0.6	10	0	0.0	100	44	0.3	126	35	0.3
Diaptomus sicilis	0	0	0.0	21	21	0.1	0	0	0.0	27	9	0.1	0	0	0.0
Epischura C1-C5	231	231	1.2	53	18	0.2	20	20	0.1	72	72	0.2	161	161	0.4
Epischura lacustris	20	13	0.1	0	0	0.0	10	10	0.1	0	0	0.0	0	0	0.0
Eurytemora C1-C5	186	52	1.0	72	14	0.3	15	15	0.1	55	19	0.2	51	51	0.1
Eurytemora affinis	0	0	0.0	0	0	0.0	0	0	0.0	27	27	0.1	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	10001	2658	51.8	3138	815	12.3	2134	85	10.7	4467	1694	12.5	5972	1607	13.0
Ceriodaphnia quadrangula	206	38	1.1	194	77	0.8	98	1	0.5	128	16	0.4	96	36	0.2
Chydorus sphaericus	14	14	0.1	108	49	0.4	0	0	0.0	0	0	0.0	7	7	0.0
Daphnia galeata mendotae	119	119	0.6	143	85	0.6	39	39	0.2	226	170	0.6	352	292	0.8
Daphnia retrocurva	274	4	1.4	8335	1599	32.8	4780	184	24.0	4128	555	11.6	4171	1183	9.1
Diaphanosoma leuchtenbergianum	9	2	0.0	6	6	0.0	5	5	0.0	18	18	0.1	15	15	0.0
Eubosmina coregoni	139	38	0.7	554	159	2.2	308	3	1.5	532	82	1.5	717	395	1.6
Holopedium gibberum	178	32	0.9	46	11	0.2	44	15	0.2	117	117	0.3	260	11	0.6
Leptodora kindtii	19	8	0.1	27	16	0.1	25	15	0.1	36	18	0.1	15	15	0.0
Polyphemus pediculus	15	8	0.1	0	0	0.0	15	15	0.1	18	18	0.1	0	0	0.0
Rotifers															
Asplanchna spp.	2972	98	15.4	524	118	2.1	328	46	1.6	466	57	1.3	1911	916	**4.2**
Total	19318	3643		25411	3749		19947	234		35743	6191		45788	7505	
Dry wt (mg/m³)	-	-		-	-		-	-		95	36.4		200	11.0	
Dry wt (µg/individual)	-	-		-	-		-	-		**2**	**0.8**		**3**	**0.2**	

TABLE 25 continued. 12 September 1974.

Species	DC-6			NDC.5-1			NDC 7-5			SDC.5-1			SDC 7-5		
	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%
Copepod nauplii	714	164	2.6	2214	131	11.5	1080	37	2.2	2109	308	12.9	1163	64	3.0
Cyclopoid copepods															
Cyclops C1-C5	5988	492	21.7	722	61	3.8	15537	1289	31.9	1316	118	8.1	13056	1552	33.2
Cyclops bicuspidatus thomasi	2225	65	8.0	23	23	0.1	4392	974	9.0	99	41	0.6	4139	594	10.5
Cyclops vernalis	0	0	0.0	0	0	0.0	-	-	-	-	-	-	-	-	-
Tropocyclops prasinus mexicanus	254	52	0.9	138	3	0.7	425	68	0.9	202	102	1.2	463	108	1.2
Calanoid copepods															
Diaptomus C1-C5	10667	171	38.6	452	179	2.4	6800	1613	14.0	576	186	3.5	8857	185	22.5
Diaptomus ashlandi	563	105	2.0	98	-	0.5	394	-	0.8	0	-	0.0	550	-	1.4
Diaptomus minutus	112	2	0.4	383	-	2.0	394	-	0.8	552	-	3.4	142	-	0.4
Diaptomus oregonensis	10	10	0.0	45	-	0.2	0	-	0.0	51	-	0.3	0	-	0.0
Diaptomus sicilis	119	119	0.4	0	-	0.0	0	-	0.0	0	-	0.0	0	-	0.0
Epischura C1-C5	73	73	0.3	103	103	0.5	109	10	0.2	279	221	1.7	207	207	0.5
Epischura lacustris	0	0	0.0	0	0	0.0	0	0	0.0	4	4	0.0	0	0	0.0
Eurytemora C1-C5	9	9	0.0	82	8	0.4	81	51	0.2	339	114	2.1	43	43	0.1
Eurytemora affinis	9	9	0.0	4	4	0.0	45	45	0.1	4	4	0.0	0	0	0.0
Limnocalanus C1-C5	18	18	0.1	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	9	9	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp.	9	9	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	4320	732	15.6	12285	1661	64.1	12420	458	25.5	8136	1174	49.8	6924	400	17.6
Ceriodaphnia quadrangula	18	18	0.1	168	17	0.9	188	9	0.4	401	35	2.5	220	64	0.6
Chydorus sphaericus	0	0	0.0	15	15	0.1	0	0	0.0	62	62	0.4	26	26	0.1
Daphnia galeata mendotae	47	29	0.2	0	-	0.0	99	-	0.2	80	-	0.6	53	-	0.1
Daphnia retrocurva	1917	390	6.9	165	-	0.9	5258	-	10.8	428	-	2.6	2127	-	5.4
Diaphanosoma leuchtenbergianum	0	0	0.0	11	11	0.1	0	0	0.0	27	12	0.2	26	26	0.1
Eubosmina coregoni	139	44	0.5	134	6	0.7	361	33	0.7	476	62	2.9	611	115	1.6
Holopedium gibberum	9	9	0.0	82	14	0.4	145	85	0.3	66	66	0.4	43	43	0.1
Leptodora kindtii	19	19	0.1	7	0	0.0	33	33	0.1	23	8	0.1	35	35	0.1
Polyphemus pediculus	0	0	0.0	7	7	0.0	0	0	0.0	31	24	0.2	9	9	0.0
Rotifers															
Asplanchna spp.	391	48	1.4	2035	100	10.6	937	17	1.9	1068	1068	6.5	628	114	1.6
Total	27641	1705		19203	1481		48278	2134		16721	3544		39881	523	
Dry wt (mg/m³)	-	-		65	7.8		-	-		66	30.4		158	42.7	
Dry wt (µg/individual)	-	-		2	0.3		-	-		2	1.1		3	1.0	

TABLE 25 continued. 12 September 1974.

Genus	NDC.5-2			NDC 7-1			SDC.5-2			SDC 7-1		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	2435	642	9.8	1458	170	10.2	1136	199	9.5	1467	280	8.6
Cyclopoid copepods												
Cyclops C1-C5	2600	522	10.5	2947	297	20.5	1036	176	8.6	110	62	0.6
Cyclops C6	62	62	0.2	35	2	0.2	50	33	0.4	50	19	0.3
Tropocyclops	110	12	0.4	258	40	1.8	226	46	1.9	29	20	0.2
Calanoid copepods												
Diaptomus C1-C5	1286	17	5.2	1164	75	8.1	534	41	4.5	226	109	1.3
Diaptomus C6	746	287	3.0	261	36	1.8	539	6	4.5	395	13	2.3
Epischura C1-C5	922	200	3.7	342	129	2.4	463	51	3.9	145	42	0.8
Epischura C6	28	17	0.1	0	0	0.0	36	6	0.3	7	1	0.0
Eurytemora C1-C5	346	226	1.4	47	10	0.3	284	138	2.4	215	20	1.3
Eurytemora C6	5	5	0.0	6	6	0.0	8	8	0.1	12	12	0.1
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods												
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Cladocerans												
Bosmina	5545	2067	22.4	5237	286	36.5	3402	695	28.4	12981	989	75.9
Ceriodaphnia	473	156	1.9	189	41	1.3	245	73	2.0	7	7	0.0
Chydorus	94	18	0.4	75	36	0.5	102	11	0.8	49	34	0.3
Daphnia	6766	510	27.3	598	177	4.2	1793	220	14.9	55	0	0.3
Diaphanosoma	56	23	0.2	24	1	0.2	13	13	0.1	0	0	0.0
Eubosmina	911	189	3.7	221	48	1.5	412	9	3.4	18	3	0.1
Holopedium	194	8	0.8	64	15	0.5	116	13	1.0	8	8	0.0
Leptodora	45	23	0.2	26	2	0.2	14	1	0.1	4	4	0.0
Polyphemus	17	6	0.1	6	6	0.0	26	5	0.2	7	1	0.0
Rotifers												
Asplanchna	2165	328	8.7	1394	32	9.7	1564	172	13.0	1326	249	7.8
Total	24807	5307		14356	405		11999	1829		17111	331	
Dry wt (mg/m^3)	70	10.9		-	-		40	14.9		77	22.8	
Dry wt (μg/individual)	2	0.8		-	-		3	0.6		4	1.3	

TABLE 26. Mean abundance, standard deviation of the mean, percentage composition, and dry weights for zooplankton collected at 30 stations on 19 October 1974. Two samples were counted at each station.

Species	DC-1			DC-2			DC-3			DC-4			DC-5		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	914	-	9.5	481	-	2.3	760	-	4.1	422	46	1.9	665	43	2.9
Cyclopoid copepods															
Cyclops C1-C5	2202	-	22.9	4833	-	23.6	4457	-	24.3	5655	744	25.7	7198	979	31.8
Cyclops bicuspidatus thomasi	265	-	2.7	534	-	2.6	553	-	2.9	661	24	3.0	1439	350	6.3
Cyclops vernalis	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	854	-	8.9	1140	-	5.6	1080	-	5.8	1200	126	5.5	906	128	4.0
Calanoid copepods															
Diaptomus C1-C5	1071	-	11.1	5335	-	26.0	6132	-	32.6	8403	1559	38.1	8307	1752	36.3
Diaptomus ashlandi	0	-	0.0	21	-	0.1	52	-	0.3	13	13	0.1	69	34	0.3
Diaptomus minutus	132	-	1.4	157	-	0.8	173	-	0.9	205	10	0.9	195	26	0.9
Diaptomus oregonensis	0	-	0.0	21	-	0.1	17	-	0.1	46	46	0.2	0	0	0.0
Diaptomus sicilis	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Epischura C1-C5	108	-	1.1	282	-	1.4	155	-	0.8	1471	301	6.7	319	122	1.4
Epischura lacustris	0	-	0.0	31	-	0.2	35	-	0.2	145	2	0.7	118	37	0.5
Eurytemora C1-C5	48	-	0.5	42	-	0.2	43	-	0.2	7	7	0.0	25	14	0.1
Eurytemora affinis	0	-	0.0	0	-	0.0	26	-	0.1	7	7	0.0	19	7	0.1
Limnocalanus C1-C5	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus sp	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Cladocerans															
Bosmina longirostris	229	-	2.4	115	-	0.6	173	-	0.9	341	153	1.5	344	85	1.5
Ceriodaphnia quadrangula	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	0	-	0.0	10	-	0.1	35	-	0.2	52	52	0.2	0	0	0.0
Daphnia galeata mendotae	96	-	1.0	262	-	1.3	60	-	0.3	137	137	0.6	213	135	0.9
Daphnia retrocurva	1805	-	18.8	5774	-	28.1	3282	-	17.5	2460	197	11.2	2007	38	8.9
Diaphanosoma leuchtenbergianum	0	-	0.0	21	-	0.1	0	-	0.0	0	0	0.0	37	2	0.2
Eubosmina coregoni	1792	-	18.6	1360	-	6.6	1641	-	8.7	688	64	3.1	685	24	3.0
Holopedium gibberum	24	-	0.2	63	-	0.3	35	-	0.2	26	13	0.1	13	13	0.1
Leptodora kindtii	72	-	0.7	21	-	0.1	69	-	0.4	72	32	0.3	80	2	0.3
Polyphemus pediculus	0	-	0.0	0	-	0.0	0	-	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna spp.	12	-	0.1	10	-	0.1	9	-	0.0	7	7	0.0	19	7	0.1
Total	9624	-		20514	-		18705	-		22031	2263		22656	3327	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (μg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Genus	NDC.5-1			NDC.5-2			NDC 1-1			NDC 1-2			NDC 2-1		
	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%	$\#/m^3$	$S\bar{x}$	%
Copepod nauplii	1045	165	6.8	476	148	5.9	927	362	3.8	813	362	3.8	456	226	3.2
Cyclopoid copepods															
Cyclops C1-C5	2915	1005	18.9	2685	395	19.1	2870	624	18.3	4802	342	22.6	2492	494	17.6
Cyclops C6	1035	71	6.7	534	111	3.8	419	119	2.7	549	51	2.6	428	81	3.0
Tropocyclops	1346	277	8.7	1208	264	8.5	2072	2	13.2	1394	564	6.6	1061	202	7.5
Calanoid copepods															
Diaptomus C1-C5	1700	91	11.0	1595	425	11.3	1899	215	12.1	5039	417	23.7	1436	298	10.1
Diaptomus C6	199	61	1.3	156	43	1.1	224	116	1.4	369	49	1.7	208	18	1.5
Epischura C1-C5	199	199	1.3	142	32	1.0	100	28	0.6	304	127	1.4	117	79	0.9
Epischura C6	27	11	0.2	3	3	0.0	17	10	0.1	59	59	0.3	18	13	0.1
Eurytemora C1-C5	86	67	0.6	104	2	0.7	42	15	0.3	151	45	0.7	46	10	0.3
Eurytemora C6	47	47	0.3	0	0	0.0	0	0	0.0	31	5	0.1	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	2	2	0.0	0	0	0.0	0	0	0.0	6	6	0.0
Cladocerans															
Bosmina	87	5	0.6	138	47	1.0	107	53	0.7	50	2	0.2	73	15	0.5
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	8	8	0.1	2	2	0.0	3	3	0.0	38	14	0.2	2	2	0.0
Daphnia	4182	411	27.1	5248	1393	37.1	5143	1558	32.7	5696	1355	26.8	5551	1463	39.2
Diaphanosoma	4	4	0.0	17	14	0.1	3	3	0.0	25	1	0.1	2	2	0.0
Eubosmina	2504	681	16.2	1713	419	12.1	1830	20	11.6	1789	247	8.4	2161	562	15.3
Holopedium	18	5	0.1	9	9	0.1	6	6	0.0	26	26	0.1	8	5	0.1
Leptodora	20	12	0.1	95	24	0.7	53	28	0.3	75	4	0.4	83	27	0.6
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	8	8	0.1	5	3	0.0	9	9	0.1	0	0	0.0	0	0	0.0
Total	15427	2846		14130	2842		15723	2696		21217	2714		14148	2239	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Genus	NDC 2-3			NDC 4-1			NDC 4-3			NDC 4-4			NDC 7-1		
	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%	#/m³	S$\bar{x}$	%
Copepod nauplii	985	8	5.5	1252	124	8.4	502	10	2.7	428	53	2.1	602	119	3.8
Cyclopoid copepods															
Cyclops C1-C5	3747	413	20.9	2426	172	16.3	3869	145	21.0	5403	389	26.7	3157	144	19.8
Cyclops C6	876	135	4.9	458	52	3.1	591	139	3.2	957	125	4.7	686	68	4.3
Tropocyclops	1625	143	9.1	1274	290	8.6	1318	324	7.1	696	32	3.5	1456	216	9.1
Calanoid copepods															
Diaptomus C1-C5	3663	699	20.4	1537	195	10.3	6969	1003	37.8	9585	453	47.4	2463	602	15.4
Diaptomus C6	303	194	1.7	166	12	1.1	573	110	3.1	641	121	3.2	398	145	2.5
Epischura C1-C5	556	387	3.1	87	8	0.6	454	244	2.5	55	25	0.3	378	254	2.4
Epischura C6	63	38	0.4	0	0	0.0	102	32	0.6	37	11	0.2	28	17	0.2
Eurytemora C1-C5	126	59	0.7	87	44	0.6	33	33	0.2	21	7	0.1	111	22	0.7
Eurytemora C6	13	13	0.1	0	0	0.0	30	30	0.2	3	3	0.0	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	16	16	0.1
Cladocerans															
Bosmina	88	21	0.5	145	98	1.0	363	97	2.0	156	28	0.8	153	80	1.0
Ceriodaphnia	4	4	0.0	0	0	0.0	0	0	0.0	3	3	0.0	0	0	0.0
Chydorus	8	8	0.0	7	7	0.0	4	4	0.0	26	14	0.1	33	33	0.2
Daphnia	4463	556	24.9	4426	1172	29.8	2899	525	15.7	1307	48	6.5	4431	464	27.7
Diaphanosoma	42	34	0.2	4	4	0.0	7	7	0.0	13	7	0.1	6	6	0.0
Eubosmina	1280	168	7.2	2903	205	19.6	613	131	3.3	810	41	4.0	1950	266	12.2
Holopedium	17	8	0.1	14	14	0.1	67	59	0.4	32	25	0.2	0	0	0.0
Leptodora	46	13	0.3	64	43	0.4	25	3	0.1	32	9	0.2	117	83	0.7
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	4	4	0.0	4	4	0.0	4	4	0.0	31	16	0.2	6	6	0.0
Total	17912	1381		14852	1243		18441	1770		20238	582		15991	109	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Genus	NDC 7-3			NDC 7-5			SDC.5-1			SDC 1-1			SDC 1-2		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	934	220	4.7	429	27	2.3	1091	96	6.5	916	270	4.2	474	176	4.2
Cyclopoid copepods															
Cyclops C1-C5	4633	673	23.5	5978	344	32.5	2794	357	16.7	3161	77	14.5	2735	465	24.3
Cyclops C6	879	244	4.5	834	312	4.5	695	121	4.1	1073	493	4.9	258	5	2.3
Tropocyclops	997	99	5.0	765	49	4.2	1059	102	6.3	2114	542	9.7	546	152	4.9
Calanoid copepods															
Diaptomus C1-C5	7515	1044	38.2	8045	1204	43.8	1461	223	8.7	2498	870	11.5	2733	134	24.3
Diaptomus C6	284	53	1.4	312	8	1.7	159	0	1.0	580	131	2.7	174	43	1.5
Epischura C1-C5	152	2	0.8	64	5	0.4	507	220	3.0	692	431	3.2	234	29	2.1
Epischura C6	47	35	0.2	80	25	0.4	19	6	0.1	11	1	0.1	6	6	0.1
Eurytemora C1-C5	20	20	0.1	4	4	0.0	86	42	0.5	85	10	0.4	42	18	0.4
Eurytemora C6	17	6	0.1	21	21	0.1	3	3	0.0	5	5	0.0	12	0	0.1
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods															
Canthocamptus	0	0	0.0	0	0	0.0	0	0	0.0	6	6	0.0	0	0	0.0
Cladocerans															
Bosmina	188	26	1.0	130	78	0.7	124	54	0.7	294	128	1.4	0	0	0.0
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	0	0	0.0	46	23	0.3	26	26	0.2	19	19	0.1	12	0	0.1
Daphnia	2453	85	12.5	984	314	5.3	5729	1378	34.2	6118	1402	28.1	3463	263	30.8
Diaphanosoma	6	6	0.0	4	4	0.0	10	10	0.1	17	7	0.1	84	60	0.8
Eubosmina	1425	249	7.2	607	138	3.3	2877	479	17.2	4000	323	18.4	384	1	3.4
Holopedium	0	0	0.0	21	6	0.1	0	0	0.0	30	30	0.1	24	0	0.2
Leptodora	130	3	0.7	43	2	0.2	118	73	0.7	131	0	0.6	54	6	0.5
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers															
Asplanchna	6	6	0.0	15	15	0.1	3	3	0.0	0	0	0.0	0	0	0.0
Total	19865	1506		18382	2464		16762	2632		21747	2781		11234	484	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Genus	SDC 2-1			SDC 2-3			SDC 4-1			SDC 4-3		
	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%	#/m^3	S$\bar{x}$	%
Copepod nauplii	1090	67	10.2	432	154	4.3	999	43	8.9	782	250	3.5
Cyclopoid copepods												
Cyclops C1-C5	2109	9	19.8	2452	331	24.2	2093	157	18.8	6218	132	27.8
Cyclops C6	384	53	3.6	370	4	3.7	361	3	3.2	1247	151	5.6
Tropocyclops	865	53	8.1	499	66	4.9	960	196	8.6	750	138	3.4
Calanoid copepods												
Diaptomus C1-C5	1001	328	9.4	2233	235	22.0	1302	344	11.7	7914	208	35.4
Diaptomus C6	112	10	1.1	119	4	1.2	148	10	1.3	617	188	2.8
Epischura C1-C5	402	224	3.8	761	97	7.5	325	149	2.9	304	2	1.4
Epischura C6	19	7	0.2	13	13	0.1	17	2	0.2	100	13	0.4
Eurytemora C1-C5	130	39	1.2	103	44	1.0	67	23	0.6	24	24	0.1
Eurytemora C6	9	9	0.1	12	3	0.1	0	0	0.0	48	48	0.2
Limnocalanus C1-C5	0	0	0.0	0	0	0.0	0	0	0.0	8	8	0.0
Limnocalanus C6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods												
Canthocamptus	0	0	0.0	0	0	0.0	5	5	0.0	0	0	0.0
Cladocerans												
Bosmina	254	5	2.4	88	1	0.9	135	41	1.2	651	349	2.9
Ceriodaphnia	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus	6	6	0.1	5	0	0.1	5	5	0.0	0	0	0.0
Daphnia	1992	67	18.7	2127	67	21.0	1815	6	16.3	2109	401	9.4
Diaphanosoma	6	1	0.1	0	0	0.0	14	2	0.1	40	8	0.2
Eubosmina	2208	55	20.7	859	40	8.5	2815	101	25.2	1408	54	6.3
Holopedium	10	10	0.1	10	6	0.1	15	4	0.1	48	48	0.2
Leptodora	39	34	0.4	44	8	0.4	70	12	0.6	36	4	0.2
Polyphemus	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Rotifers												
Asplanchna	17	7	0.2	5	0	0.1	15	4	0.1	52	20	0.2
Total	10651	317		10132	455		11162	414		22358	383	
Dry wt (mg/m^3)	-	-		-	-		-	-		-	-	
Dry wt (μg/individual)	-	-		-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Species	DC-6			SDC.5-2			SDC 7-3		
	#/m³	Sx̄	%	#/m³	Sx̄	%	#/m³	Sx̄	%
Copepod nauplii	930	215	2.5	1449	151	5.5	923	306	3.1
Cyclopoid copepods									
Cyclops C1-C5	9683	1332	26.4	5434	230	21.2	7679	413	25.5
Cyclops bicuspidatus thomasi	1375	461	3.7	1240	432	4.8	1588	107	5.3
Cyclops vernalis	0	0	0.0	0	0	0.0	0	0	0.0
Tropocyclops prasinus mexicanus	972	106	2.6	1820	388	7.1	1390	162	4.6
Calanoid copepods									
Diaptomus C1-C5	16498	1826	44.9	4105	88	16.0	11166	192	37.1
Diaptomus ashlandi	351	31	1.0	84	-	0.3	318	-	1.1
Diaptomus minutus	293	77	0.8	135	-	0.5	169	-	0.6
Diaptomus oregonensis	168	135	0.5	34	-	0.1	0	-	0.0
Diaptomus sicilis	17	17	0.0	0	-	0.0	0	-	0.0
Epischura C1-C5	1321	1172	3.6	886	886	3.5	624	434	2.1
Epischura lacustris	101	34	0.3	0	0	0.0	131	46	0.4
Eurytemora C1-C5	42	42	0.1	125	24	0.5	132	26	0.4
Eurytemora affinis	0	0	0.0	6	6	0.0	19	2	0.1
Limnocalanus C1-C5	8	8	0.0	0	0	0.0	0	0	0.0
Limnocalanus macrurus	0	0	0.0	0	0	0.0	0	0	0.0
Harpacticoid copepods									
Canthocamptus sp	0	0	0.0	8	8	0.0	0	0	0.0
Cladocerans									
Bosmina longirostris	435	81	1.2	295	8	1.1	787	187	2.6
Ceriodaphnia quadrangula	0	0	0.0	0	0	0.0	0	0	0.0
Chydorus sphaericus	42	42	0.1	19	19	0.1	9	9	0.0
Daphnia galeata mendotae	252	119	0.7	0	-	0.0	106	-	0.4
Daphnia retrocurva	2528	166	6.9	7495	-	29.2	3813	-	12.7
Diaphanosoma leuchtenbergianum	51	52	0.1	12	13	0.0	9	9	0.0
Eubosmina coregoni	1326	561	3.6	2388	232	9.3	948	58	3.2
Holopedium gibberum	92	26	0.3	6	6	0.0	62	62	0.2
Leptodora kindtii	67	0	0.2	113	38	0.4	131	46	0.4
Polyphemus pediculus	33	33	0.1	0	0	0.0	0	0	0.0
Rotifers									
Asplanchna spp.	159	74	0.4	8	8	0.0	53	53	0.2
Total	36744	6153		26674	2943		30825	743	
Dry wt (mg/m³)	-	-		-	-		-	-	
Dry wt (μg/individual)	-	-		-	-		-	-	

TABLE 26 continued. 19 October 1974.

Genus	SDC 4-4			SDC 7-1			SDC 7-5		
	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%	#/m^3	$S\bar{x}$	%
Copepod nauplii	565	154	3.2	1699	107	8.7	958	112	3.1
Cyclopoid copepods									
Cyclops C1-C5	5284	159	29.8	3099	469	15.8	10886	1848	35.6
Cyclops C6	1006	252	5.7	598	137	3.0	1977	480	6.5
Tropocyclops	485	72	2.7	614	32	3.1	1252	240	4.1
Calanoid copepods									
Diaptomus C1-C5	7479	715	42.2	1536	403	7.8	8666	1902	28.3
Diaptomus C6	231	60	1.3	171	2	0.9	591	175	1.9
Epischura C1-C5	191	101	1.1	412	262	2.1	664	498	2.2
Epischura C6	40	14	0.2	0	0	0.0	100	72	0.3
Eurytemora C1-C5	21	21	0.1	301	174	1.5	0	0	0.0
Eurytemora C6	0	0	0.0	0	0	0.0	0	0	0.0
Limnocalanus C1-C5	174	123	1.0	0	0	0.0	0	0	0.0
Limnocalanus C6	39	12	0.2	0	0	0.0	26	26	0.1
Harpacticoid copepods									
Canthocamptus	0	0	0.0	15	15	0.1	0	0	0.0
Cladocerans									
Bosmina	299	51	1.7	535	108	2.7	473	29	1.5
Ceriodaphnia	0	0	0.0	8	8	0.0	26	26	0.1
Chydorus	43	43	0.2	0	0	0.0	53	53	0.2
Daphnia	1479	132	8.4	6303	1965	32.2	3899	988	12.7
Diaphanosoma	0	0	0.0	27	4	0.1	26	26	0.1
Eubosmina	273	33	1.5	4110	973	21.0	819	27	2.7
Holopedium	31	14	0.2	0	0	0.0	95	29	0.3
Leptodora	31	4	0.2	144	40	0.7	47	33	0.2
Polyphemus	0	0	0.0	6	6	0.0	0	0	0.0
Rotifers									
Asplanchna	43	17	0.2	0	0	0.0	61	5	0.2
Total	17715	379		19576	3819		30620	6459	
Dry wt (mg/m^3)	-	-		-	-		-	-	
Dry wt (µg/individual)	-	-		-	-		-	-	